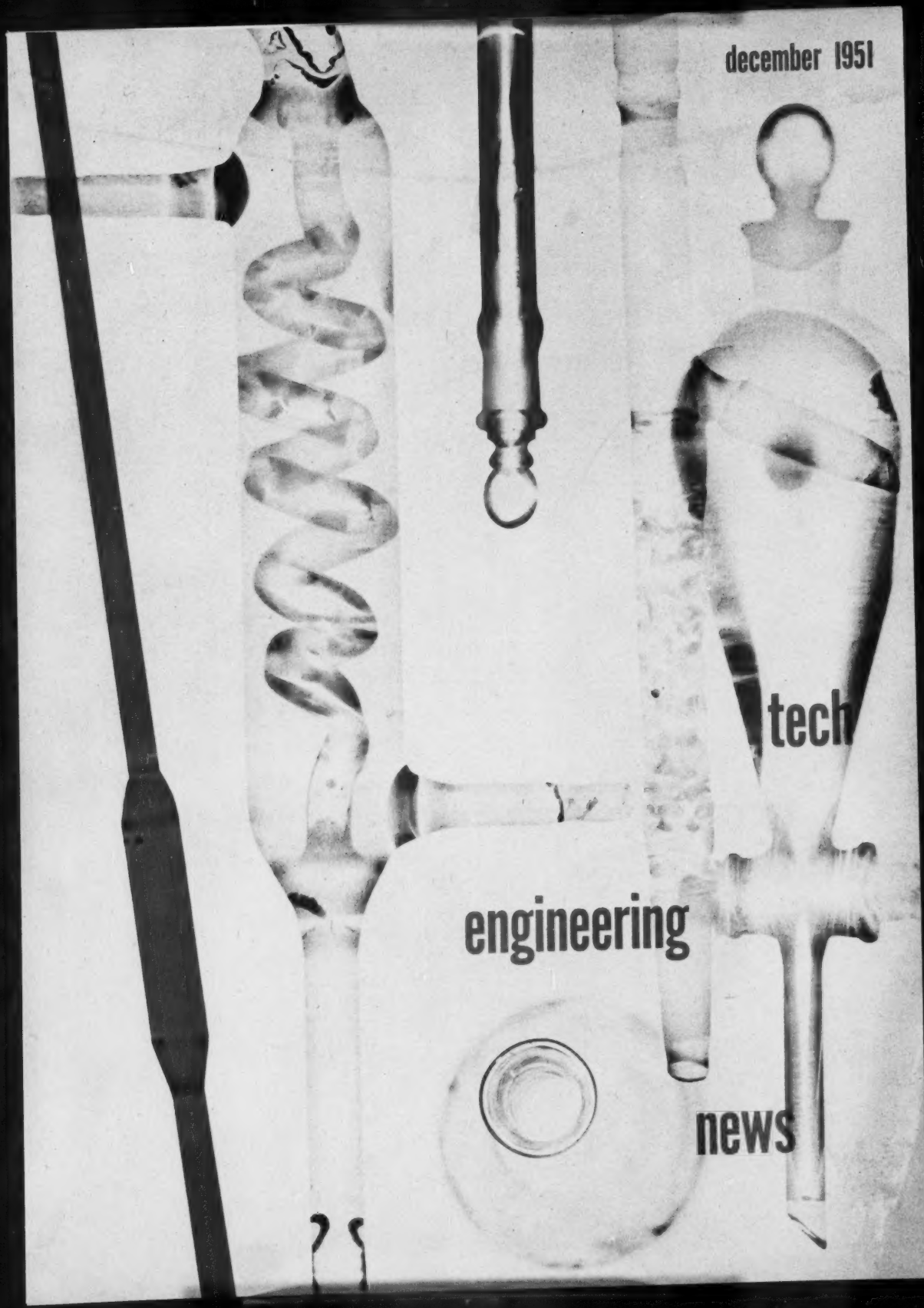
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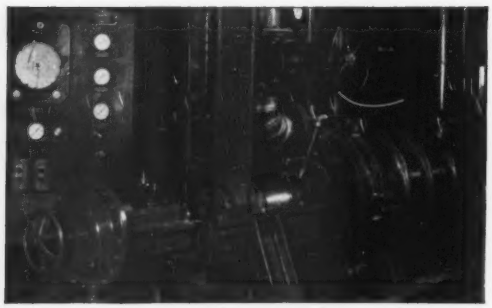
Another page for **YOUR BEARING NOTEBOOK**



How to help a plug keep plugging

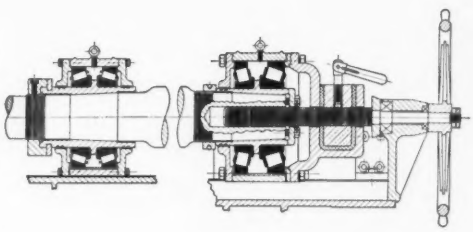
Pulp for paper making is chewed up inside this Jordan engine by a cone-shaped plug that forces the pulp against knife edges in the shell. Clearance between plug and shell must be held extremely close, so the designers mounted the plug shaft on Timken® bearings. Timken bearings take radial and thrust loads in any combination, keep shafts in positive alignment. Deflection and end movement are eliminated.

Mounting plug shaft bearings

The application shown here uses four single-row Timken tapered roller bearings mounted in pairs for the thrust and floating ends of the plug shaft. They are mounted directly on tapered sleeves and adjusted by means of shims between the cup follower and bearing housing.

The right hand or thrust end bearing assembly carries the thrust load and is clamped on the shaft by means of an end cap and cap screws. A nut next to the tapered sleeve facilitates removal of the bearing assembly.

Both thrust and floating ends are free to move laterally as the plug and shell are adjusted for clearance. Closures are of the piston-ring type.



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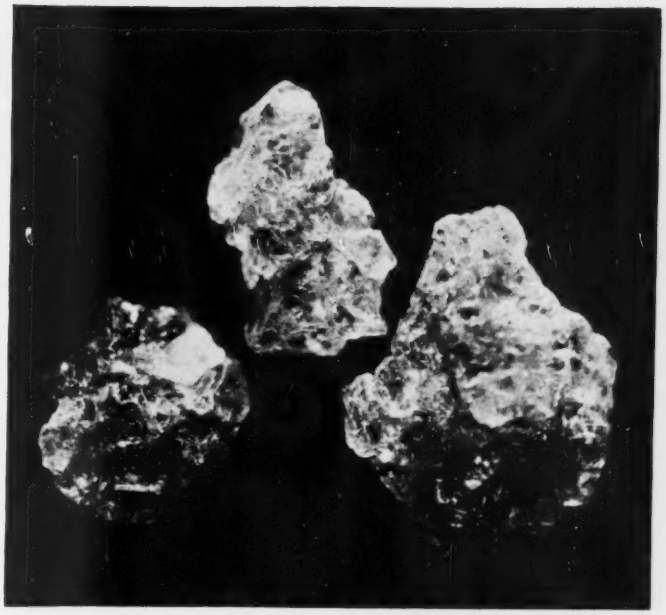

The answer "Fused Aluminum Oxide" gives you a passing mark. But, it's not just ordinary fused alumina. It's Norton 32 ALUNDUM* abrasive in a single crystal, containing more than 99% pure fused alumina — hailed as the "greatest abrasive contribution to increased grinding production in more than 40 years."

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Gordon R. Finlay, Ph.D., Cornell '42, examines a specimen with the Metallograph in the Physical Testing Laboratory at the Norton electric furnace plant in Chippawa, Canada.

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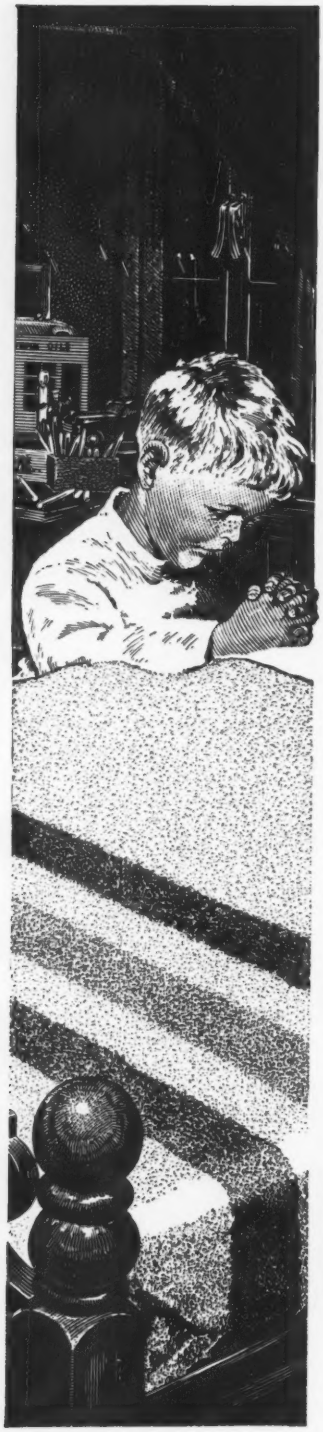

Jimmy said *two billion prayers*

"'God bless everybody!' he said . . . short and sweet.

"Then I kissed him goodnight, tucked him in, put out the light and went downstairs.

"That was a *big* order! Two billion people on this earth . . . and Jimmy was praying for them *all!*

"Now . . . if *you* were going to have that many people blessed, what *one* big blessing would you wish for them all?

"Freedom! What finer thing than Freedom for all the peoples of the world? Why, anybody who knows what our Freedom really means would give his eyeteeth to be an American citizen. Let's see why:

"Here we have freedom of religion. Our newspapers can say anything they want and so can we, short of libel, slander or sedition. Our kids are taught Freedom from kindergarten up. Here we have a free choice of places to live in, businesses to go into or jobs to work at, like mine at Republic (you ought to see the steel we're producing down at the plant!)

"Come voting time, nobody sees us mark our ballots . . . nor can he know *whom* we vote for. And we can squawk our heads off in town meetings or write what we think to our Congressmen . . . and nobody puts us in jail for it.

"As long as we don't step on the other fellow's Freedom, we Americans are the freest people in the world. But there are plenty of people trying to rob us of those Freedoms and run things *their* way. *Outside* enemies . . . but we have plenty *inside,* too. They sneak into our schools, businesses, unions, social clubs . . . *everywhere!*

"Let's keep an eye on those who attack our Freedoms . . . while Jimmy prays for the other two billion whose greatest blessing would be the Freedoms we already *have!*"

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Republic Building, Cleveland 1, Ohio

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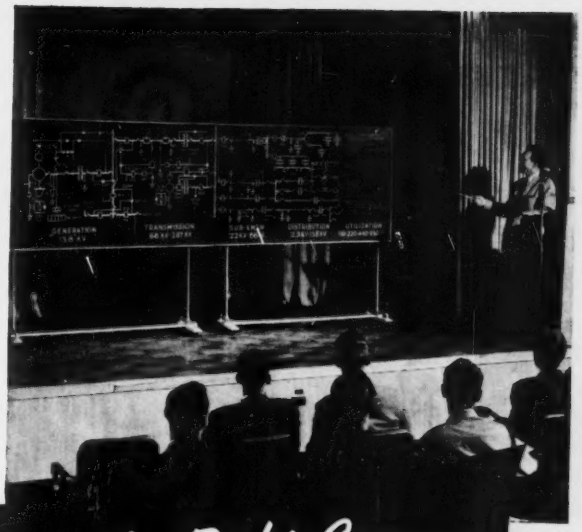

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Tapping an Open Hearth Steel Furnace
Photo by Bethlehem Steel Company

Published monthly during the school year at Walker Memorial, Cambridge 39, Massachusetts, by the undergraduates of the Massachusetts Institute of Technology. Entered as second class matter, at the Post Office, June 1, 1920, at Boston, Massachusetts under the Act of March 3, 1879. Copyright 1951 by The Tech Engineering News. Subscription per year $1.75. Foreign $2.50. One copy 25 cents.

the future of the engineer

By Prof. George de Santillana

A Navy Department expert from M. I. T. was complaining the other day in my presence: "We are snowed under with gadgets. I have come to fear them more than the Russians." The tale he was telling is certainly one of our times; it extends to all the Services and even far beyond. Naval Operations sets up research bureaus to design new devices for modern warfare. The bureaus sell their devices to the Fleet, which in turn finds itself beset and bedevilled by an ever-increasing set of new gadgets, each of which, of course, needs a production, operation and service chain extending down into the capacity of the ship, back into the productive machinery of the nation. Each device fills a new need, no doubt, but it raises three more of the same order, and with each new device goes a new chance of breakdowns.

It is clear that diminishing returns, to put it mildly, are apt to set in. That is why special evaluation offices are supposed to analyze the positive and negative aspects of each development in that light, and to allot the available resources and manpower only to the most desirable. Such evaluation offices, even the few there are, suffer at present from a chronic shortage of competent workers. Said my friend: "We can get excellent electronic engineers by the dozen, but they think only in terms of production. We have already a sight too many Sorcerer's Apprentices as it is."

This little story may point to some serious problems of tomorrow throughout our economy. As mechanization continues (our immediate answer to Russian manpower superiority) and as automatization succeeds it, which it will, we are bound to find ourselves facing crucial problems with only hasty thinking to cope with them.

We obviously lack a certain essential new type of citizen.

As engineering becomes the most essential of the professions, the public is apt to feel more sharply what is wrong with the present definition of the engineer's role. This has taken place to some extent already. We hear among us the frequently-voiced complaint that engineers have by no means a proportionate share of the business and administrative posts where decisions are taken. The really big jobs go to a different type of man.

This is not a matter for small correctives. Let us look at the whole problem in the historical perspective, and maybe it will make sense.

We might remember, for instance, that up to a generation ago the engineering profession had no claim to any post whatever on the policy-making levels of the nation. We might even remember that once, in a burst of optimism, the nation decided to elect an engineer to the Presidency; all that happened under him was the Great Depression. No, I am forgetting the Smoot-Hawley Tariff, the failure of naval disarmament, the Manchurian Incident, and the early collapse of international security. *Requiescat.* It was not his fault after all. The nation wanted somebody to run a boom and never think of a bust. It wanted a capable man, and it got him. It did not want a statesman, and it did not get one.

Statesmen are recruited among men with a political or legal background, or both. Most of the time they do not turn out to be very satisfactory. They live and prosper by small deals and compromises; their vision is cramped and backward; and yet they are what the public wants. There are good reasons for it.

The man who makes policy is not the man with the know-how; he is the man with the know-what; or at least he can sell himself as such to public opinion. He uses the know-how men as experts, but he himself must know essentially the scale of importance of things — what comes first, what comes after, and what comes last. And he must be able to work out this scale from an experienced understanding of people and of what makes them tick.

I have drawn a rather idealized picture of the policy-maker; but this is how he stands in the imagination of those who call him to leadership. A community is essentially a conservative affair — it wants men who are resourceful and flexible enough to keep it going and prospering without changing anything if possible. The

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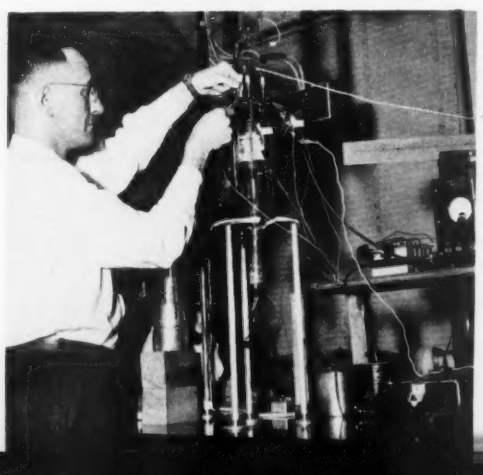

revolutionary development in amplification

$250 amplification for $35

By David Sternlight, '54

What is this mysterious thing called "high-fidelity"? People strive for it, spend large sums of money to achieve it, and yet are unsatisfied, whether they own a two hundred dollar amplifier or a ten dollar amplifier. Audio fans gather together and nod learnedly over response curves and distortion figures. Yet most of these same "experts" will come dashing to every meeting which shows a new amplifier for which some claim or other is made. It is just such an amplifier I wish to talk about now. But I, and everyone I spoke to, who attended the meeting of the Institute of Radio Engineers Audio Group, left firmly convinced that the amplifier which we saw and heard was something out of the ordinary and definitely good. This instrument, the "Noble-Young" amplifier, was developed by two M. I. T. men with the idea that it was to be a "low cost, high-fidelity amplifier." It is in the same class, performance wise, as two hundred dollar amplifiers, and it costs about thirty-five dollars to build from readily available components. There is nothing critical or tricky about it; it uses standard techniques given a new application.

A word or two here about standards for high-fidelity seems to be in order. In order to reproduce music successfully, a system must have what is known as "presence" — the ability to reproduce a flute so it sounds like a flute, the ability to give you the illusion that you are listening to the music through a window, as it were, on the wall of the concert hall. To the technical mind, this means that the amplifier must have certain frequency response characteristics; that is, it must reproduce all tones within a certain range of frequencies with approximately equal loudness. The human ear can hear tones from sixteen cycles to about fifteen thousand cycles. Very few loudspeakers can reproduce this range, however. While performance of high-frequency speakers begins to fall off at about thirteen kilocycles, these speakers will still reproduce higher notes, and while the ear cannot hear them, it is believed that these ultrasonic notes have a psychological effect on the brain which gives the higher instruments their "tingling realism." So an amplifier must be able to reproduce tones well above the range of hearing. Distortion in an amplifier is another bugaboo. It can occur in several ways. Harmonic distortion, which is distortion in the overtones, is tolerable at some five per cent, while a high quality amplifier will have no more than two per cent. This is at full power; as the power of the amplifier is reduced, of course, the distortion goes down. Another form of distortion is called intermodulation distortion, a fifty dollar word for distortion because of the interaction between a high note and a low note. This can be about ten per cent at full power using forty and two thousand cycles, but should not be more than roughly eight per cent for high quality. In the matter of frequency response, ± 1 db from thirty to fifteen thousand cycles is considered acceptable, while a high quality amplifier will probably have a response of ± 1 db from twenty to twenty thousand cycles.

(*Continued on page 20*)

feedback in audio amplifiers

By F. M. Young

The problem of using feedback around the output transformer of an audio amplifier has received much attention in recent issues of audio publications. The consensus is that the amount of feedback which can be used is limited by the quality of the output transformer. Actually, however, the opposite is true. The principles involved in the problem are well-known to the servomechanism people, but have not had a definite statement in audio journals.

The criterion for the stability of feedback is that the transform locus of the feedback loop does not encircle the point (−1,0). A convenient rule of thumb which may be used to determine whether or not this

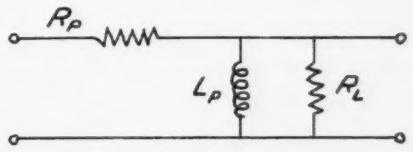

Fig. 1

criterion is fulfilled is that the rate of attenuation should not exceed ten db/octave at the frequency for which the gain around the loop falls to one.

At low frequencies the output transformer may be represented by the circuit in Fig. 1. R_P corresponds to the d-c resistance in the primary circuit and to core losses, L_P is the primary inductance, and R_L is the load impedance referred to the primary. The response of the circuit falls off at most six db/octave. Hence, the attenuation in the rest of the amplifier should be less than four db/octave at the frequency at which the loop gain is equal to one. The transformer may be characterized by a "lower half power point," f_l, that is, the frequency at which its attenuation is three db. Below that frequency the attenuation may be considered to be six db/octave. The lower half power point may be as high as one hundred cycles for an inexpensive transformer, while it may be as low as ten cycles for a more expensive transformer. If it is desired to use forty db of feedback (a gain reduction factor of 100) the loop gain will fall to one at approximately $f_l/100$. Hence, the amplifier gain, exclusive of output transformer, should have at most four db/octave of attenua-

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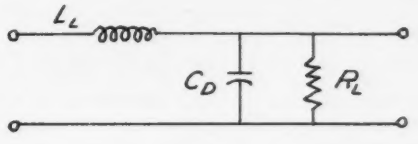


Fig. 2

sulfur

Critical Foundation of Industry

By Tom Cantrell, '55

Photos courtesy Freeport Sulfur Company

Sulfur is a foundation stone of our industrial economy. Very few industries would be unaffected by an extreme shortage of this mineral. At present, due to our vastly expanded defense economy, we are faced with an increasing scarcity of this element.

The amount of sulfur in the earth's crust has been estimated at 0.1 per cent. At present, the largest worked deposits of elemental sulfur are the salt domes of the Texas and Louisiana Gulf Coast. Reserves are estimated at fifty-five million tons, which means that at the current rate of production, this source will be exhausted within eleven years.

The greatest proportion of sulfur is devoted to the production of sulfuric acid, which finds many uses in industry and in agriculture. The acid has a high boiling point, about 640° F.; it is a good dehydrating agent; it is able to dissolve copper and silver; it can be used to catalyze many reactions. These properties are utilized in many processes.

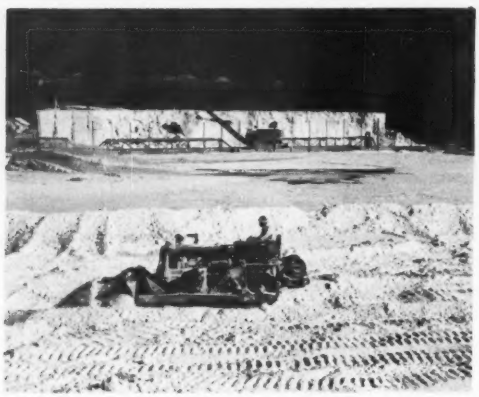
The fertilizer industry is the largest single consumer of sulfuric acid. Soluble phosphate is an important part of fertile soil. Tricalcium phosphate is an abundant salt, but is only slightly soluble. It is treated with sulfuric acid to make a soluble acid phosphate fertilizer (called superphosphate of lime).

The acid property of sulfuric acid is also utilized in the metals industry. The principal use is in pickling baths for iron and steel. Detergents have tended to replace acid for this purpose since the war. Still, the steel industry alone consumed nearly four per cent of the total sulfur production in 1949.

Sulfuric acid is used in treating lube-oil stocks. The amount consumed for this purpose varies as the emphasis in production shifts between the different types of petroleum products. Any decline in consumption for lube-oil treatment is more than offset by the number of newer processes utilizing the acid.

The properties of sulfuric acid make it extremely useful in the chemical industry. It is employed as an acidifying and neutralizing agent for the concentration of nitric acid and hydrogen peroxide. Processes for the manufacture of hydrochloric acid, phosphoric acid, aluminum sulfates, and other inorganic compounds utilize this acid. It is used in organic chemistry as a sulfonating agent and as a catalyst in the preparation of many compounds.

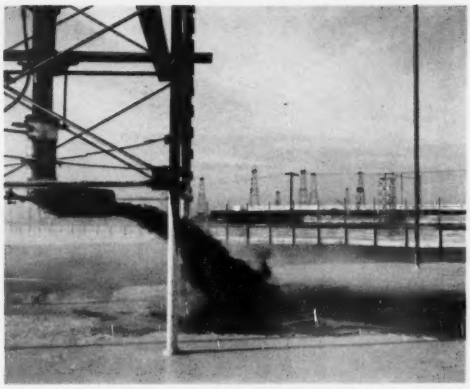
Sulfur vats, containing many thousands of tons of the yellow mineral, are broken down for shipment by a large electric shovel.



A tractor is at work preparing a vat site to receive molten sulfur at Freeport Sulfur Company's Grande Ecaille, Louisiana, mine. In the background a sulfur vat is being broken down for shipment.

Although sulfuric acid is the most widely used sulfur compound, others are in great demand. Carbon disulfide is employed in large quantities in the viscose rayon industry. The production of this material has been expanding rapidly. Sulfur dioxide finds use as a refrigerant, a bleaching agent, and as a solvent in petroleum refining. It is obvious, then, that sulfur is of critical importance in our economy.

Due to the great demand for sulfur, the four major producing companies in the United States find themselves in the pleasant position of having a large and steady income. The returns on their investment are



Molten sulfur pours into a large vat at Freeport Sulfur Company's Hoskins Mound mine in Texas. As the liquid spreads over the surface, it cools and hardens into 99½ per cent pure sulfur.

comparatively enormous. During the depression, when basic industries like steel and petroleum were forced to cut production drastically, the average sulfur producing company showed a return of twelve per cent on its investment. Recently the average has been about thirty-five per cent or almost twice as large as the oil industry's.

So great is the present boom that leaders in the industry have been worrying about selling too much of their product. It seems that the demand for sulfur is increasing rapidly. Our whole industrial economy is being put on a peace-plus-war footing.

Our sulfur supply was entirely adequate during the great production period of the Second World War. Why should we be short now? We're producing about five million tons annually, which is thirty per cent over our wartime rate. Yet we are faced with a domestic deficit of some 300,000 to 500,000 tons. Where is all our sulfur going?

In the first place, domestic and defense production has increased. Large government orders of chemicals, explosives, and other products are supplemented by great increases in paper, fertilizer, and domestic chemical production. The consumption of sulfur has been roughly an exponential curve for the last sixty years, with the demand doubling about every decade. In the present boom the demand is shooting up much faster.

Furthermore, domestic demands do not account for all of our sulfur production. The European countries which were ravaged by the war are now buying on our market. Due to the cheapness of American elemental sulfur, much of their equipment has been built or adapted to its use. Even now, when the supply is tight, the price is still low enough to make the development of other sources financially unprofitable. These countries would still like to depend on us for their supply of sulfur derivatives.

So our sulfur producers find themselves in a vice, one jaw of which is the dwindling supply, the other, the increasing demand. They are trying to shove back both jaws at once, by decreasing our exports, seeking new sources, and developing new recovery methods. All of these courses present knotty problems.

The reduction of exports has to be accomplished very tactfully. Almost all of the Atlantic Pact nations are our customers, and a severe curtailment of our exports would put a real economic burden on them. In fact, the European Recovery Administration accounts for sixty per cent of our exports today. True, there are deposits of pyrites (iron sulfide) in Italy, but the cost is prohibitive compared to our elemental sulfur. Since the present shortage, one Italian producer has been getting $140 per ton compared to the American price of $21 per ton. European manufacturers can hardly afford this price difference. Spain also has important deposits of pyrites, but for the last few years it has been politically divorced from Western Europe. The sulfur situation may have had some weight in the decision to reopen diplomatic relations with France.

The plan which the industry has tentatively adopted involves the reduction of exports by 100,000 tons per year, or about eight per cent of the present total, for at least three years and possibly eight more. In this way the foreign users would have a better chance to develop new sources or recovery processes, while our domestic demand could be satisfied. Other nations could also convert their present equipment for the use of pyrites. Although the price of United States sulfur will probably rise some twenty-five per cent in the next few years, at least there will be enough to go around.

There have been a few recent discoveries which promise some hope for the future. A new dome has been found in Louisiana which will probably produce half a million tons annually after the ten million dollar refinery is completed. In Mexico, a salt dome containing an estimated one and a half million tons will be tapped soon. A few promising pyrite deposits have been discovered in Canada recently.

The problem facing the industry and the nation is not a simple one, and no clear-cut solution is in sight. We had better find one quickly.

Sulfur is being broken down from a large vat and loaded aboard a train at Freeport Sulfur Company's Hoskins Mound, Texas, mine. Sulfur is one of the cheapest elements, selling for less than one cent a pound.

the development of the quantum theory

The Foundation of Modern Physics

By Sol Aisenberg, G.

In this short paper I shall attempt to outline the evolution of quantum mechanics up to the matrix mechanics of Heisenberg and the wave mechanics of Schrödinger. The presentation will be completely non-mathematical, and the physical explanations will be made as simple as possible in order to permit the basic pattern to be easily grasped. Because of the increased complexity of the subject, it will be inadvisable to attempt to discuss, in elementary terms, the present day quantum mechanics.

The basic feature of quantum mechanics involves a new *Weltanschauung*. The most fundamental change consisted of a breakdown of the classical concept of causality, according to which every event is completely determined by previous events. It was realized that the causal laws of the macroworld do not necessarily carry over into the microworld. Causality cannot be applied to atomic systems because causality has meaning only when we can observe a sequence of events without introducing an external influence. Heisenberg has shown freedom from perturbation to be impossible for any atomic event. According to Einstein, the basis of quantum mechanics is of a statistical nature concerning an aggregation of identical systems, and can be verified only by a series of repeated measurements.

Another important feature of quantum mechanics is the abandonment of the pictorial scheme of analyzing atomic phenomena. An important aspect of classical physics was the postulation of a simple model or prototype in order to determine the basic mechanism and laws of physical events. Further experiments soon revealed the inadequacy of theories in terms of models patterned after familiar objects. A radical improvement was made by Heisenberg who started with the view that classical principles could not give a true picture of atomic laws. He was convinced that any attempt to form a visual picture of atomic physics was useless. Above all, he thought that only quantities not susceptible to direct observation should be excluded from atomic theory. Thus quantum mechanics cannot be visualized because it is a deliberate rejection of pictorial thinking.

These drastic revisions in the basic philosophy of physics were not caused by mere desire for change, but were due to the irresistible pressure of experience. We will now consider the major experimental facts that forced the development of the present quantum theory. It will be seen that quantum mechanics arose because of the failure of classical mechanics to explain, among other phenomena, the wave and particle nature of light, the energy radiation pattern of hot bodies, the photoelectric effect, and the spectral line patterns produced by the various elements.

In the seventeenth century, the two rival theories of light were the particle theory supported by Newton, and the wave theory supported by Huygens. Both theories were necessary to explain the apparently dual (wave and particle) nature of light. The corpuscular theory, supported by the prestige of Newton, was dominant in Newton's time and for almost a hundred years after his death, until 1801, when Thomas Young proposed the interference of light waves as an explanation of Newton's rings, interference fringes, and diffraction bands. In 1818, Fresnel developed a mathematical theory of interference, and also explained the polarization of light, a phenomenon which could not be explained satisfactorily by the corpuscular theory. Finally, in 1850, the crucial experiment was performed by Foucault, who showed that the velocity of light in water was slower than in air, as predicted by the wave theory, and not faster as predicted by the corpuscular theory.

The wave theory received even more conclusive confirmation from James Clerk Maxwell, who concluded that light is an electromagnetic phenomenon, and proved theoretically that electromagnetic waves would travel with a velocity equal to that of light. The actual existence of these electromagnetic waves was proven by Hertz in 1887, when he measured them in the laboratory. It is interesting to note that when Hertz performed the experiment that confirmed Maxwell's wave theory of light, he also noticed a small secondary phenomenon which was a manifestation of the Hertz or photoelectric effect. It will be seen later that the photoelectric effect was used by Einstein to show the existence of the photon, a particle of light in direct opposition to the wave theory of light so nicely verified by Hertz.

We now turn to the question of radiation of energy by heated bodies, the classical problem of black body radiation. Two important laws were formulated on the basis of classical physics. The first law, proposed by Wien, was accurate for short wavelengths, while the other, proposed by Rayleigh-Jeans, was accurate for long wavelengths. In 1900, Max Planck, by means of empirical patchwork, succeeded in obtaining a formula which reduced to the Wien radiation law for short wavelengths, and reduced to the Rayleigh-Jeans radiation law for long wavelengths. Thus the Planck formula agreed very well with experiment. Planck, however, was now faced with the task of finding some theoretical justification for the formula he had so nicely synthesized. This he was able to do only by assuming that energy was emitted or absorbed as quanta, or in discrete units, with the energy proportional to the frequency of the radiation.

This assumption of Planck was so radical that it was not until 1905, when Einstein extended Planck's quantum hypothesis and applied it to a powerful explanation of the photoelectric effect, that the idea of quantized energy began to challenge the wave hypothesis. Einstein stated that not only was energy emitted and absorbed in discrete units, but each quantum must behave as if it were a wave-like particle. Einstein used the photon theory to explain the photoelectric effect which had been discovered during Hertz's verification of Maxwell's wave theory as noted previously. The photoelectric effect consists of the emission of electrons from a metal surface which is exposed to ultraviolet light. There were several experimental aspects of the photoelectric effect which could not be accounted for by classical physics, but were easily

(*Continued on page 24*)

weather rhythms

Climatic Patterns Affect Civilization

By Ronald Howard, '55

The first act of a normal person when he arises in the morning is to glance through the window to determine the day's weather. Whatever the state of the weather may be, he usually attributes it to chance, without considering that the conditions on any day may fit a general pattern. Nevertheless, general patterns of weather, climatic cycles, have long been recognized by meteorologists as significant phenomena. So obvious is it that climate changes in cycles, and so important is climate to man, that scientists are continually striving to solve the problem of identifying the rhythms of weather. The idea of climatic cycles has occurred to scientific men from Plato onward, but the real discovery of climatic cycles, which means the computation and verification of their length, is a modern achievement. Some of the longer cycles, those of centuries in duration, are only partly discovered; their lengths have not been definitely established. Other and shorter cycles, however, have been determined with considerable mathematical exactness.

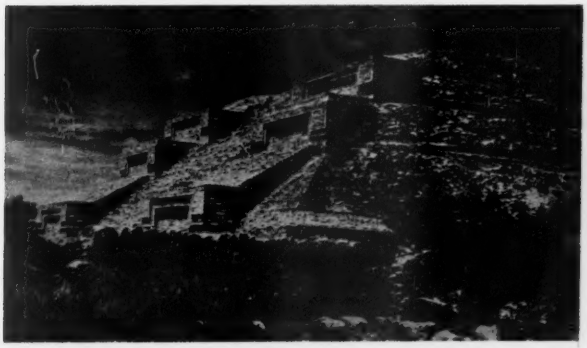
One of the most positively established of all climatic cycles is that discovered by the eminent Viennese climatologist, Eduard Brückner. Over a period of several years, Brückner surveyed data on temperature, rainfall, and other scattered conditions which had been collected over a period of two centuries. Finally, he evaluated all his data and from his comparisons he deduced a cycle averaging between thirty-five and thirty-six years in length. This cycle has been discerned in weather records for most parts of the world. Why there is such regular variation and why it is 35.5 years long has not yet been discovered, but there is little doubt that warm, dry weather for seventeen or eighteen years is likely to be succeeded by a similar period of cold, wet weather.

Another important climatic cycle has been established which has a duration of eleven years and which almost certainly corresponds to the cycle of variations of sunspots. Actual records kept for over two centuries show that these solar blemishes reach a maximum of number and extent about every eleven and one-half years, on the average. These sunspots are signs of exceptional solar activity, and since the sun is the fundamental manufacturer of all weather, it is plausible enough that cycles of weather should correspond with cycles of the sun's condition. The idea is, however, more than a theory. Plenty of corroboration is to be obtained by observation, especially in tropical regions. Because of varying rainfall or increases and decreases in the rate of evaporation, the levels of tropical lakes which are not too greatly affected by other conditions rise or fall in phase with the weather. Studies of such lakes in Africa and Australia show that high water marks and low water marks are reached at alternate periods of eleven years. This variation is in close correspondence with the cycles of sunspot activity. As a specific example, we may take the case of the great drought in Central Africa which occurred in the years 1911 and 1912. This was a period of low sunspot activity, and correspondingly, of low water level in the lakes. Eleven years later, at a time of minimum sunspots, the levels of Lake Albert and Lake Victoria fell rapidly, and another great drought ensued. To complete the human linkage, old inhabitants of Nyasaland have noticed that famines in that country occur at the same average interval of ten or eleven years.

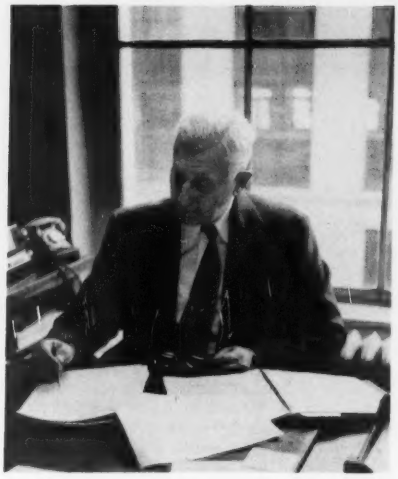
This more or less regular occurrence of the droughts that bring famine was first noticed, so far as history reveals, by the hero of one Bible story — Joseph. Joseph became the first man to identify a climatic cycle and put his knowledge to use when he interpreted the Pharoah's famous dream of seven fat kine and seven lean ones as depicting seven years of plenty and seven years of famine. Joseph's fourteen-year cycle could have evolved into today's eleven-year period, since weather rhythms seem to change slightly from century to century.

African climate is not the only verification of this theory of sunspot-climate linkage. Long-term records of temperature and rainfall corroborate it. In parts of South America the weather has been shown to follow roughly the weekly variations in sunlight intensity. Australian rock deposits reveal that the sun has been following its eleven-year cycle for at least two million years. Marks left by Swiss and Canadian glaciers show that they have advanced or receded according to the same cycle. Layers of clay deposited each spring for thousands of years on the bottoms of Swedish lakes

(*Continued on page 26*)



Entrance to the Pratt School of Naval Architecture and Marine Engineering is dominated by two huge anchors.



Professor George C. Manning, in charge of the Department, at his desk.

course xiii

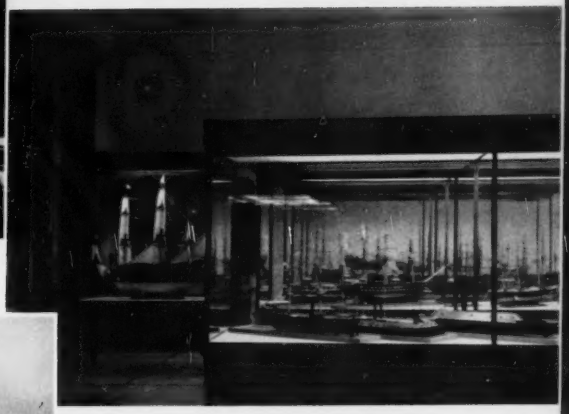
By the T. E. N. Staff

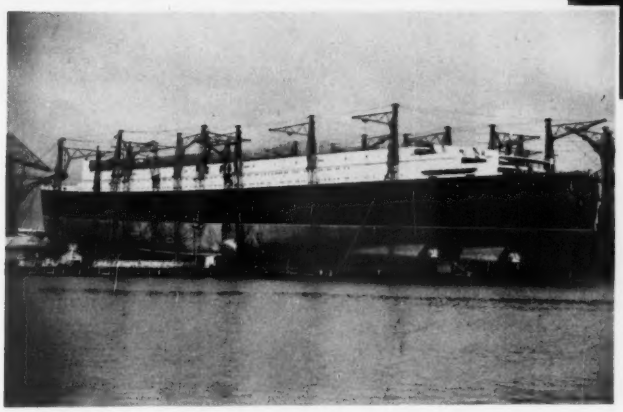
A great deal has been written about ships, but little enough about the men who make them possible. From the very tiniest craft to the massive floating cities, they are masterpieces of design and engineering. It would not be far wrong to say that even architects and engineers are sometimes startled by the hugeness and beauty of their creations. For even the simplest of investigations exposes hundreds of details that must be worked out in order to make the ship possible: Details of machinery, piping, heating, ventilation, fittings, safety devices, accommodations, auxiliaries, and many more, all of which must be considered with much more careful regard to weight, space, economy, reliability, and replacement than if they were to be installed in almost any other structure.

It is not difficult, therefore, to understand why it is impossible to learn all there is to know about ships in a lifetime, let alone in four years of study. This fact is well known in the Department of Naval Architecture and Marine Engineering here at M. I. T., one of the few of its kind in the country. The students are therefore taught the basic principles and problems involved in the design and building of ships, with the feeling that the rest will come more easily with experience after graduation. With the fundamentals of engineering and their applications to the marine field tucked in their heads, the students of this course are well on their way to becoming masters in one of man's most fascinating arts.

Professor Evers Burtner instructing in the drawing room, where students spend a great deal of time.

The expert craftsmanship of Mr. Buchanan is responsible for the many fine models made in the ship model shop for research and study.





Professor L. Troost, regularly in charge of the Model Testing Tank at Wangeningen, in Holland, has joined the Staff this year to give several Graduate Courses in Ship and Propeller Design.

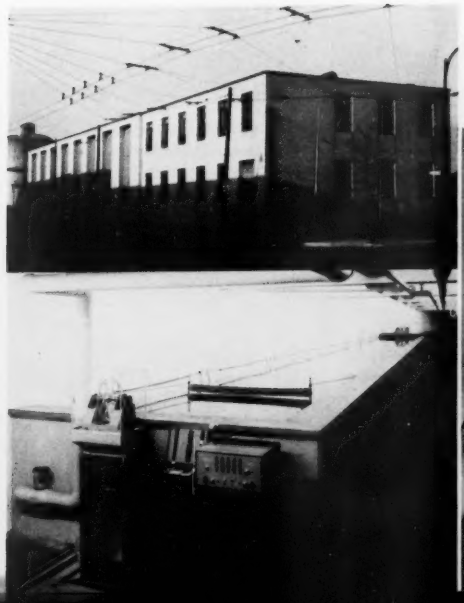
Part of the fine ship model collection housed in the Museum on the first floor of Building Five.

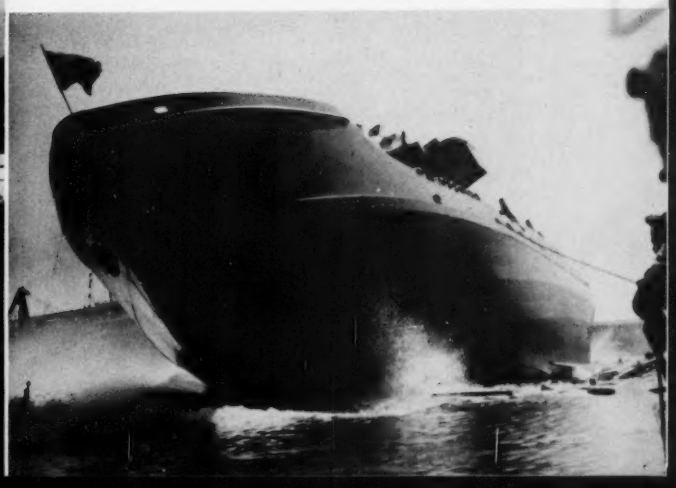
The plans, diagrams and calculations required to build a large ship such as the *Queen Elizabeth* would easily fill a number of her staterooms.

The new Hydromechanics Laboratory, housing the towing tank.

The tank itself is small, but compact and efficient.

The day of launching is a long-remembered one for the architects, the engineers, and all who had a hand in the planning and building of the ship.





amateur radio

A Scientific Hobby

By Nereo Agostinelli, '54

What is amateur radio? It is a scientific hobby, a means of acquiring personal skill in the ever-expanding field of radio communication, and an opportunity to exchange ideas with fellow men. Our planet is, in effect, growing smaller every day. Events and problems in the remotest parts of the world can have a decisive effect upon our lives, wherever we may live. Consequently, a deeper understanding of the "other fellow's" point of view, his way of life, ideals and cultural background can lead, utopian as this may sound, to happier conditions for all.

Scattered over the entire globe are more than 130,000 radio amateurs from the extreme tip of "Tierra del Fuego" to Greenland and the North Pole, all performing a service defined in international law as one of "self-training intercommunications and technical investigation carried on by duly authorized persons interested in radio technique solely with a personal aim and without pecuniary interests." They make up a

Short-wave station W1BB is an example of the neat efficiency possible in a ham's radio room.

fraternity of some of the most hobby-happy individuals in the world. While most of us spin our radio dials between 550 and 1620 kilocycles hunting for our favorite radio comedian or musical program, the ham works patiently across his government-allocated short wave bands looking for someone calling "CQ", the plaintive cry of the lonely radio amateur looking for a mate. Most amateurs are equipped with either a radiotelephone or a radiotelegraph transmitter. At this point someone may wonder how they can understand each other if they speak different languages. This handicap is overcome by two internationally accepted codes. One is a set of forty-three "Q" signals which deal with essential technical information. "QSY," for example, asks, "Shall I change to transmission on another frequency?" "QRM" reports, "I am being interfered with." The other type of code is a set of abbreviations and, though based mainly on the English language it is understood by hams all around the world. Thus: "QRK, OT? CUL VY 73 ES 88 2 UR XYL CL" is the official ham lingo for, "What is the readability of my signals, old timer? See you later. Very best regards and love and kisses to your wife. I am closing my station."

In the early days the ham station, housed in the basement or the attic, was a scrap heap of twisted wire, half open cans and spark plugs; today the amateur's transmitter has moved into a more respectable corner of the house and will not take more room than a large television set. The average transmitter costs $100. although the figure goes as low as $30 and as high as $7,000. Ninety per cent of all ham transmitters are

W1MX makes contacts all over the world, as illustrated by these QSL cards from Moscow and St. Pierre.

home-assembled while practically all the receiving sets are bought ready made.

Today there are 90,000 radio amateurs in this country alone. Their ranks furnish the nation with professional communication experts and executives. They have won the gratitude of the nation for the heroic performances of their members in times of national disaster. They include people from all walks of life. There are about sixteen hundred women hams in the United States. Both Herbert Hoover, Jr. and Prince Abd el Moneim of Egypt are ardent hams. If

(*Continued on page 34*)

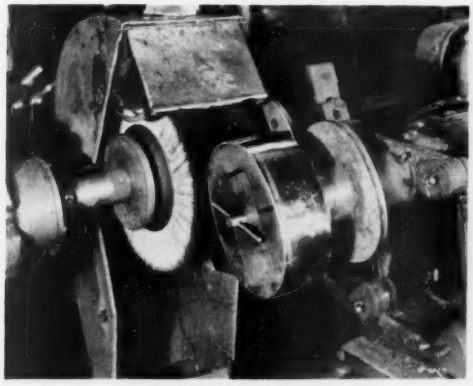
the "brush-off" in a nice way

The Power Brush in Industry

Most of us think of a brush as something that lies on a dresser, stands in a broom closet or hangs on a hook above the sink.

Webster's Collegiate Dictionary defines it as "a device composed of bristles, wire, etc., set in a suitable back or handle for cleaning, scrubbing, painting, etc." That does not suggest mechanized, or power brushes, which are the most important brushes of our time.

Power brushing has found its place in almost every conceivable industry. Almost every item we know uses brushes in its industrial process.



Your steel toaster shell was probably finished this way.

Passenger planes, passenger cars, trucks, motor craft, furniture, rugs, furnaces, stoves, plumbing fixtures, clothes, shoes, silverware, cutlery, paper, paper containers, camera films, light bulbs, fluorescent lights, bottle caps, matches, razor blades, shatter-proof glass and things as dissimilar as brick and cellophane, are all given the "brush-off." Not to mention brushes that clean grapefruit, oranges, apples, and potatoes, scale fish and scour bottles.

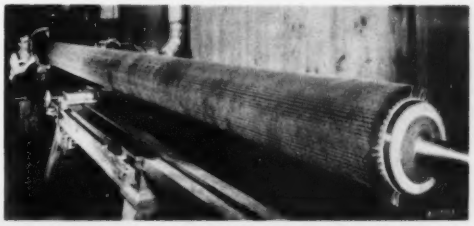
About as typical a case of power brushes at work is the job a small brush, no larger than the end joint of your little finger, did to increase airplane production. This is one of a variety produced by the Osborn Manufacturing Co.

The wings and fuselage of airplanes are primed with a protective paint which has to be removed around many rivet holes to get a metal-to-metal bond and prevent static and interference on the plane's radio. As there are millions of rivets in a large bomber, that is quite a job. It used to be done with sandpaper discs mounted on portable tools, but the discs kept "loading up" and three crews working around the clock, sandpapering holes and changing discs, couldn't keep up with the rest of the job. A brush was devised to do this work. The operator presses the trigger of his grinder, and before you can look away, a circle of bright metal is revealed.

Work that formerly required seven or eight men per crew was done by one man. The job was speeded up 700 per cent. This is just one of hundreds of situations solved in the same manner with power brushing.

The materials from which brushes are made come from all over the world.

Wire used in brush making — steel, stainless steel, monel, bronze, copper, and brass — is made in this country and in its smallest size is finer than human hair.

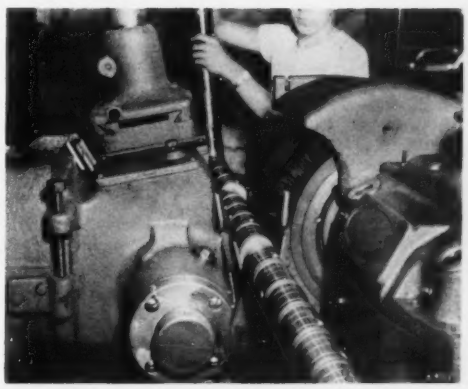


This wood-core, fiber tufted rotary brush is twelve inches in diameter and twenty-two feet long. One of the largest brushes ever made, it is used for the nap-raising operation in the manufacture of certain types of carpets.

The fiber most widely used in industrial brushes is called tampico, after the port in Mexico from which much of it is shipped. There are various grades of tampico, some of them the product of bush cactuses, like the century plant, others of tree cactuses. Rice root, or zacaton, is made from the root of a bunch grass that grows on mountainsides in Central Mexico and Guatemala. Cocoa fiber is obtained from the outer husk of the cocoanut and is produced chiefly in Ceylon and along the Malabar Coast of South India. Kittool

(*Continued on page 38*)

Pistons similar to those in your automobile are brushed with a wire brush. This operation makes assembly easier.



tech engineering news

Professional Journal of the Undergraduates of the
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The Managing Board expresses its regret that Charles Lenz, Art Editor, will not be able to return to the Staff until February.

Publisher's Representative

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from the editor's notebook

Letter to the Editor...

November 12, 1951

Dear Sir:

I object strongly to the statements made in your editorial in the October 1951 issue. You seem to favor the continued employment of an instructor, even after he has publicly supported Communist, clearly subversive views. You advocate a policy of obstruction, of complete noncooperation on the part of the university with any efforts by our government to insure a loyal teaching body. Surely you do not believe that the university has the moral right to close its eyes to what is occuring on campus, thereby leaving an insuperable job of enforcement in the laps of government authorities. You say, "We realize that subversive elements must be eliminated" and ther go on to create meaningless ifs, ands, and buts, which can only serve as loopholes thwarting the carrying out of justice.

This editorial is published in a journal which calls itself the *Professional Journal of the Undergraduates of M. I. T.* However, in publishing this editorial I do not think you are expressing the opinion of the Undergraduate body at M. I. T.

A TECH STUDENT

The editorial printed in this space is not intended to represent the consensus of the student body. It represents only the opinions of those whose names or initials appear beneath the editorial. It is incorrect to assume that this magazine always presents the majority views of the students here. Often the Editor's ideas may coincide with popular opinion at Tech, but this certainly is not always the case.

"Tech Student" supports an idea which appears to be, unfortunately, fairly common in Massachusetts. That is, that the Universities themselves should form committees to judge their own instructors. Those who are found "subversive" should, then, be removed. Nowhere in the letter do we find any attempt to define the term "subversive," yet the writer has no hesitation in stating that Professor Struik has "supported clearly subversive views." Justice meted out in this arbitrary manner would be at best nonuniform, more probably not worthy of the name.

Possibly the October editorial would appear more meaningful to "Mr. Tech Student" if I stated the assumptions which were made. The major supposition is that it is desirable to allow the individual the greatest degree of freedom possible in any situation. Of course, we realize that if we are to maintain an orderly society it is impossible to allow complete freedom. Therefore, a system of law and a means of enforcement is set up. Now, I am certain that the writer of the above letter would agree that it is desirable to hold restrictions to a minimum. He would probably say that our freedom stands as one of the best arguments against Communism. Yet he supports measures which would limit the freedom of expression of countless men; not only Communists, but Marxists, leftists, and liberals of many types simply because they express "subversive views" and are, in the opinion of a few men, a threat to the American way of life. He would silence many for fear of losing their jobs.

In my opinion, such action would be an unnecessary abridgment of freedom. Far more would be lost by the methods suggested by "Tech Student" than could possibly be gained in terms of national security.

S. K.

In This Issue...

Dave Sternlight's article deserves special attention. Through his connections with the Acoustics Lab, he was able to get a scoop on what we think is a really important development in the field of high fidelity reproduction.

WHERE
TENSION CONTROL
AND LEATHER
make a good team
FLAT LEATHER BELT
TENSION-CONTROLLING MOTOR BASE
In the fielder's glove, a hand controls the tension that makes the leather take hold. In the Uni-Pull drive, a tension-controlling motor base and a modern leather belt team up in practically the same way. The base maintains belt tension . . . keeping leather's high pulley grip at work, effectively transmitting power.
American LEATHER BELTING Association
Headquarters for Authentic Power Transmission Data
AL-51

the future of the engineer

(*Continued from page 6*)

political mind must be able to invent solutions out of things as they are; it is a "make-do" mind, whereas the outstanding engineer has a natural bent towards scrapping the old and starting anew on a more rational basis. Unfortunately, as one of our presidents put it, engineers often "do as they are told"; they follow a program. There is always a component of each type in the successful businessman; but when he reaches the top level, he has to rely on the political component and more or less forget the other. This explains why the top policy-making levels of the nation — and this includes the sphere of very big business — present such a prevalence of men with legal training.

The great law schools have always taken this for granted, and they strive to prepare the type of man who can shoulder responsibilities. As Justice Brandeis said, norms live only in a social context. The normative personnel must be trained to the social context. Law school graduates are taught in many manners, direct and indirect, to discriminate between what can change and what cannot — between the moral and metaphysical foundations, the historical and sociological constants, on the one hand, and the forms that can take changes in order to equalize the pressures.

This is the general picture as it has come to us in the maturing of civilization. But now it is time to say that it is beginning to get out of focus.

The prevalence of the legal and humanistic mind in policy decisions had its good reasons, but those reasons were far more cogent when economies were static, and when practically all education had a humanistic and legal cast.

Today, we are carried along in the rapids of the industrial revolution, and new possibilities arise at every turn which are beyond the prudent and Baconian legal mind. If the nature of our times had been only a little better realized by statesmen, if they had been able to think in terms of things as they were at the time and not in terms of age-old prejudices, no one would have embarked in the First World War, and thus we would never have had the Second. Today, the nations of Europe are thrashing around the bottom of a pit they dug for themselves, and their heritage has fallen to industrial superpowers that history had kept in reserve. Today, it is we, the successors, who have to think hard; for our present peril arises from the rivalry of a power which, although industrially weaker than we are, has embraced the Industrial Revolution with fury and has put all its resources, not only material but human and spiritual as well, in the hands of a reckless and ruthless new type of social engineer called the Commissar.

Our way, we trust, is going to be different. But having said this, we cannot just sit down and trust to the infinite wisdom of our political leaders. They have to "make-do" with what they have, and that includes a choice assortment of old ideas, old catchwords, old cards, and the rag-tag and bob-tail of old classes the world over. Those come to us like filings to a magnet, but their value as assets is doubtful and their attachment is alarming. Meanwhile, we are submerged in a flood of new technical necessities, as I have described in the beginning, and hope that some computing machine can make order out of the chaos.

It doesn't work that way.

At every moment we must make decisions on the physical level which will affect the future one way or the other.

Clearly we need a new type of leadership among the citizenry; we also need a new type of public servant. We need men who can understand the situation, who are not mere executors and expediters, nor know-how boys, nor gadget-crazy producers and consumers, nor push button visionaries; but personalities who can deal with modern problems in their full scope and make their voices heard.

We cannot expect present policy-makers, however well advised, to understand the range of physical possibilities that are within our grasp, nor the range of physical consequences that a political decision would imply, whether it be war, international agreements, domestic reform, or cold-war strategies.

It takes men who not only know about the present organization and its values, but who are capable of dealing with the *changes* of organization that are the essence of a modern society; who can translate existing values from one set of conditions into another.

This is where the future type of engineer comes in. We need him in a hurry, but he is nowhere in sight.

For engineers who like challenging work

Meeting this country's civilian and military production needs is providing an endless variety of problems to challenge the best of engineering brains.

Here at Western Electric, as in all big manufacturing concerns, the job calls for the pooling of special skills by mechanical, electrical, industrial, chemical, metallurgical and other engineers—to come up with the right answers.

The primary job at Western Electric—the manufacturing unit of the Bell System—is to make the thousands of kinds of telephone equipment needed to keep this country's telephone service going and growing. Many of these products are so tiny or so unbelievably complex—calling for such precision—that you'd think they could be made only by skilled technicians working under closely controlled *laboratory* conditions. Yet Western Electric engineers devise machines and techniques which enable workers, after a short training period, to turn these things out under *factory* conditions. There's a real kick in doing work like that!

And, because of the specialized experience gained in our regular telephone job, Western Electric is also working on many important communications and electronic equipment projects for the Armed Forces. Such things as radar fire control systems for the Navy's biggest guns and for anti-aircraft guns—radar bombing systems for America's largest planes—multi-channel radio sets for all types of military aircraft—electronic marvels to launch, guide, and explode the latest guided missiles—provide opportunities galore for creative production planning.

Both of Western Electric's jobs—telephone and military—are vital to this country's present and future strength. Both are filled with challenges for the best engineers of today and tomorrow.

Western Electric

A UNIT OF THE BELL SYSTEM SINCE 1882

$250 amplification for $35

(*Continued from page 7*)

Now to get down to business. The "Noble-Young" amplifier uses a phenomenal amount of inverse feedback, forty db from the secondary of the output transformer, to be exact. The purpose of inverse feedback is to compensate for distortion and to smooth out the response curve. Forty db of feedback is equal to a "gain reduction" factor of one hundred. This means that whatever the amplifier frequency response before feedback, it must be extended by a factor of one hundred afterwards. Also, the distortion will be reduced by a factor of one hundred. This amplifier uses a five dollar power and three dollar output transformer. It is designed around these. Starting with the amplifier designed for a certain band width with good response, we merely add feedback and the band width opens up. Phase shift is a serious problem since it will tend to cause the amplifier to oscillate at sub-audible and ultrasonic frequencies. These oscillations force the tubes into non-linear operation, and the speaker is driven out of the magnetic field, producing treble distortion. Also, power is sapped by high frequency oscillation, and the grids rectify, causing more sub-audible oscillation. Therefore, the amplifier must be made very stable to prevent this. This subject is discussed quite thoroughly in the accompanying article by F. M. Young of the Acoustics Lab, one of the co-designers of this amplifier. In order to compensate for the inexpensive output transformer, which is very inefficient, we need high power in the primary. In order to get high power without large tubes and power supplies, the output stage is run Class B. This adds considerable distortion, which is one of the reasons for the large amount of inverse feedback used. A small amount of positive feedback is also added to provide negative output impedance, because as shown in Figures 1 and 2 of Mr. Young's article, the resonant circuit peak of the speaker can be compensated for in damping by a low generator impedance, and the negative resistance of the generator cancels the series resistance so that the net impedance is zero.

Most amplifiers have trouble with the volume control, with a loss of highs often amounting to twelve db at ten kilocycles with the volume control in the mid-position. To compensate for this, the input capacity of the tube following the volume control is neutralized. This amplifier is completely push-pull to eliminate undesirable phase shift. The power supply must be plate regulated if we are to use triodes, and this is complicated and expensive. If the plates are not regulated in triodes, distortion results. However, in tetrodes, the distortion is independent of plate voltage, and so we can use a cheap power supply if we regulate the screen potential. This is a lot easier than regulating plate voltage. One might ask, "Why regulate the power supply if you regulate the output with feedback?" The answer is that we then have the tube characteristics constant and we know exactly where we stand.

Now for some vital statistics. The 6Y6 model of this amplifier, using push-pull 6Y6's in the output stage, puts twenty watts out to the *voice coil* of the speaker. This is equal to sixty watts input to the primary of the cheap output transformer at extreme frequencies. At 1.5 watts to the speaker, which is good room volume, the amplifier is flat from ten to sixty thousand cycles at .1 db. At the extremes of frequencies there is .5 per cent distortion, and at the middle the distortion is so low it cannot be measured with the finest equipment in the Acoustics Lab. From the data given in this article, it should be possible for anyone with a fundamental knowledge of audio to design this amplifier. Design notes may be found in Termin's "Radio Engineering Handbook." A complete schematic will be published in a future issue of *T. E. N.*

feedback in audio amplifiers

(*Continued from page 7*)

tion at this frequency. This would mean that the amplifier should be off at most three db at one cps for the inexpensive transformer while the three db point should be at 0.1 cps for the more expensive transformer.

At high frequencies the transformer may be represented by Fig. 2 where L_L is the total leakage inductance, C_D is the distributed capacity, and R_L is the load impedance. The response of this network is shown in Fig. 3 where f_2 is the "upper half power point" and f_3 is the frequency for which the distributed capacity becomes important.

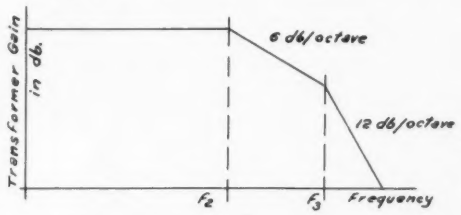

Fig. 3

The ratio of f_3 to f_2 sets the maximum gain reduction factor which can be used without additional correction networks in the amplifier. For an inexpensive transformer f_2 may be as low as ten kilocycles, while it may be as high as two hundred kilocycles for a more expensive transformer. In order to satisfy the stability criterion, the loop gain must be reduced to one before f_3 or before the high frequency attenuation of the remainder of the amplifier becomes important, whichever is lower. In order to accomplish this, a network having a characteristic shown in Fig. 4 must be added to the amplifier where X_{db} is the amount of attenuation needed to reduce the loop gain to one at the critical frequency.

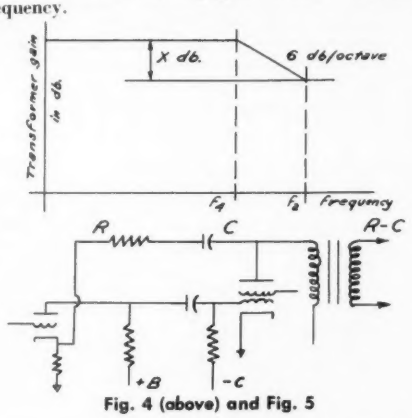

Fig. 4 (above) and Fig. 5

The compensation shown in Fig. 4 can be accomplished with the R-C network shown in Fig. 5.

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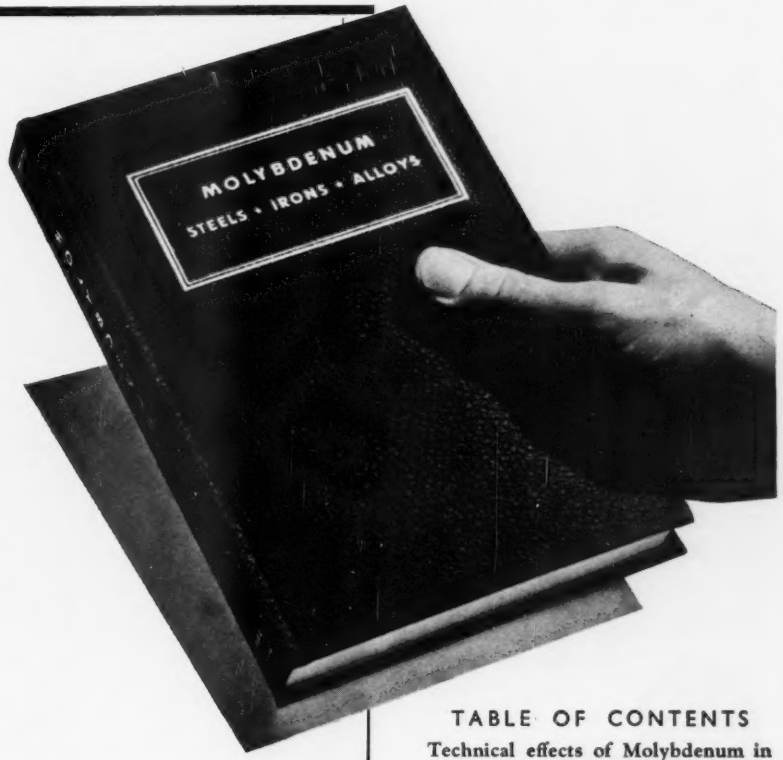

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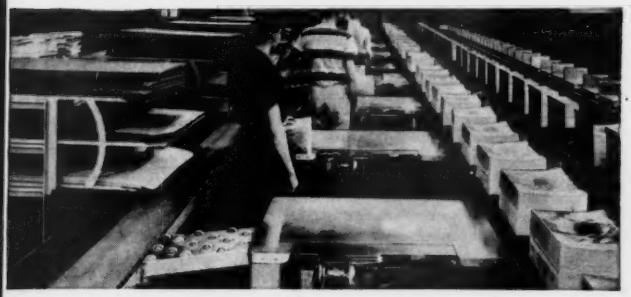

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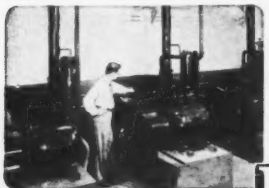

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development of the quantum theory

(*Continued from page 10*)

explained by Einstein. First, the maximum electron energy is a function of the frequency of the light; second, the number of electrons emitted is proportional to the light intensity; third, there is a threshold frequency below which electrons are not emitted from the metal surface.

In addition, the classical wave theory predicted that under normal conditions, it would take over five hundred days before an electron would be expelled from an atom. But, actual experiment has shown that if there is any time lag between illumination and emission of electrons, it must be less than 3×10^{-9} seconds. This tremendous discrepancy is too much for the wave theory. Later, in 1923, A. H. Compton was to perform an experiment which could be interpreted only in terms of the particle nature of light, thus further confirming Einstein's photon theory.

The next application of the quantum theory came in 1913, when Neils Bohr used it to explain the hydrogen spectrum, which classical physics had never been able to do. Bohr postulated the existence of special electron orbits, and the emission or absorption of a photon as the electron jumped from one orbit to another. In this way, Bohr was able to predict the hydrogen spectrum with amazing accuracy. In addition, he used his theory to explain theoretically the famous Rydberg constant, and to evaluate it to within one hundredth of one per cent accuracy. Bohr's theory was not completely valid, however, for it broke down for the more complicated elements.

The next phase of quantum mechanics entered in 1924, with de Broglie's suggestion that waves are somehow to be associated with moving particles. Like most new ideas in quantum mechanics, this was pure conjecture. The experimental verification of de Broglie's theory came in 1925 when Davisson and Germer showed that electrons have the wave nature predicted by de Broglie. Thus we see that there is a wave-particle duality for matter as well as for light.

Soon after de Broglie's contribution, W. Heisenberg developed a form of quantum mechanics which involved a new philosophy of science. The only magnitudes Heisenberg chose to work with were the observable quantities such as the frequency and intensity of the spectral lines, because as he had shown, light waves of a very short wave length are needed for the precise determination of the position of a particle, and light waves of rather long wave lengths are needed for the accurate determination of the velocity of a particle. Thus, there will always be an uncertainty in the measurement of the position and velocity of a particle. There is little doubt as to the validity of Heisenberg's uncertainty principle, since it is regarded as being well founded on empirical evidence. The Heisenberg matrix mechanics evolved out of this new approach, and with the aid of Born and Jourdan, it was developed to the point where it was capable of explaining many phenomena that could not be explained by classical physics.

Several months after the appearance of Heisenberg's work on quantum mechanics, E. Schrödinger published his theory of wave mechanics based upon the matter waves of de Broglie. The germ of the theory was contained in the famous wave equation which Schrödinger postulated. Schrödinger himself was able to unify the two theories when he proved that, in spite of the difference between the two viewpoints, his theory was mathematically equivalent to the matrix mechanics developed by Heisenberg, Born, and Jourdan. The equation gives the probability that the light quantum, or electron, is at a given point. Thus, instead of considering the motion of an electron in an orbit, we consider the motion of a probability packet in the orbit, with the electron somewhere in the packet.

Since further discussion of quantum theory would require the introduction of advanced mathematical and physical concepts, we will stop at the Heisenberg matrices and Schrödinger wave mechanics. Nevertheless, we have made considerable progress, for we now have a system of quantum mechanics which is capable of explaining all that classical physics was able to, and in addition of predicting much that is far beyond the powers of classical physics. Furthermore, a new and radical philosophy of physics has evolved in which we are content to work with "waves of probability" instead of the exact, determinate particles demanded by classical mechanics.

Recomended Reading

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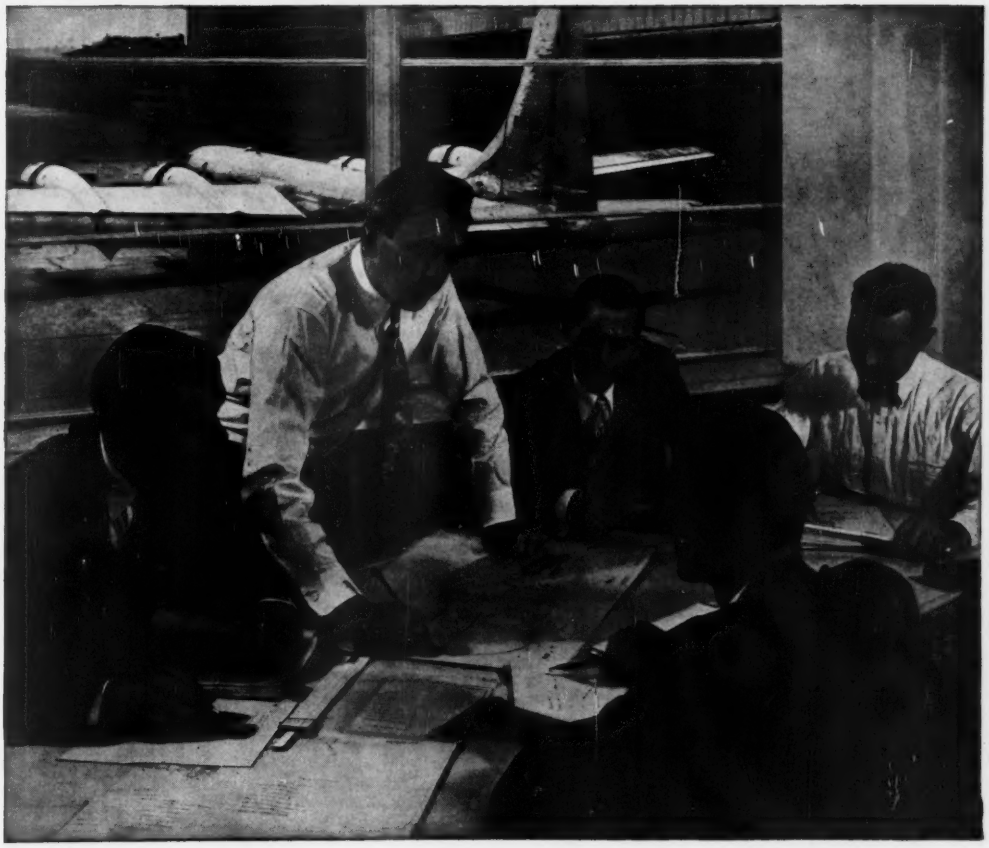

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weather rhythms

(*Continued from page 11*)

and estuaries, similar layers dredged up by Russian scientists from the bottom of the Black Sea, and variations in the annual growth of trees in California and Arizona, all supply additional corroboration of the eleven-year sunspot cycle as affecting weather.

If only this eleven-year cycle or the slightly longer Brückner cycle affected the earth's weather, the forecaster would have little difficulty in making a prediction, but, as anyone over thirty-six can testify, these two cycles are not the only ones affecting climatic conditions. There is a host of others, some short, some long, which hopeful scientists have announced as discoveries from time to time. Among those cycles which have been reported over the years are: 14 months, 28 months, 30 months, 16 years, 44 years, 95 years, 372 years. If all these cycles were plotted against time, it would be evident that at some times they would reinforce each other, whereas at other times interference would result. During the periods when the majority reinforced each other, we could expect extremes of weather — either very hot or very cold, or extremely wet or dry. When interference between cycles occurred, we could expect moderate temperature and rainfall.

There are many sources of the data needed by climatologists to discover new cycles and verify old ones. One of the most important sources of weather information is the writings and records of humans. In all ages a few sturdy, persevering persons have kept diaries, and the essential entry in almost all diaries is the state of the weather. Archivists of more official flavor are also given to noting that it was fair and warmer after Hannibal crossed the Alps and that Gaul was divided into three parts the year of the big wind. Droughts, floods, hurricanes, tornadoes, old-fashioned winters — all sorts of weather have been made immortal by one kind of history or another.

Much weather data is obtained from unexpected places. Old English tax records, for example, gave scientists something to gloat over when it was discovered that the records revealed such clues as the yields of grain and the flow of water in mill streams year after year. Egyptian hieroglyphics have supplied records of the stages of the Nile for centuries. The clay-brick libraries of Babylon have shown that Babylonian weather records were kept and that today's climatic cycles existed in ancient Babylon.

Information obtainable from these human sources is limited by the fact that written records naturally do not exist before the time of literate men. Fortunately, however, we have records of another sort that can and do go back much farther. Nearly three thousand years of weather records have been obtained by studying the growth rings of trees, especially of the Big Trees of California. These trees are of astounding antiquity; the oldest one studied was 3,120 years old when it was felled.

The method used to obtain weather data from growth rings is simple. Each normal year of their lives, these trees add growth which shows in the cross-section of sawed-off trunk as a ring. In years of plenty the ring is stouter than in those of famine; too much rain or too little shows in the character of the ring. By measuring some of the later rings and comparing these measurements with existing weather records, scientists are able to make a sort of scale which, applied to rings for years for which no weather records are available, would show what the weather had been for those earlier years.

The next step in charting the weather history of the world is to study evidence older than that of the Big Trees. Such evidence is provided by the strand lines left in the basins of lakes which had no outlet. In a round pot-like hollow in the hills of Eastern California is a flat cake of salt and brine called Searles Lake. Once Searles Lake was a real lake six hundred feet deep. When its level became sufficiently high it overflowed, filled another lake to the eastward, and finally ran off into Death Valley. The highest water level ever reached is plainly marked, to the eyes of the geologist. More than two hundred other levels of the lake, each a temporary shore line, have left their marks on the basin, forming a natural rain gage. Since the water of the lake has dried up through evaporation, it is obvious from these strand lines that California weather was once wetter than it is now, and that it fluctuated as does weather today. The strand lines are not easy to date in years, but their very existence and the scheme of their arrangement show, once more, that weather flows in cycles. (*Continued on page 30*)

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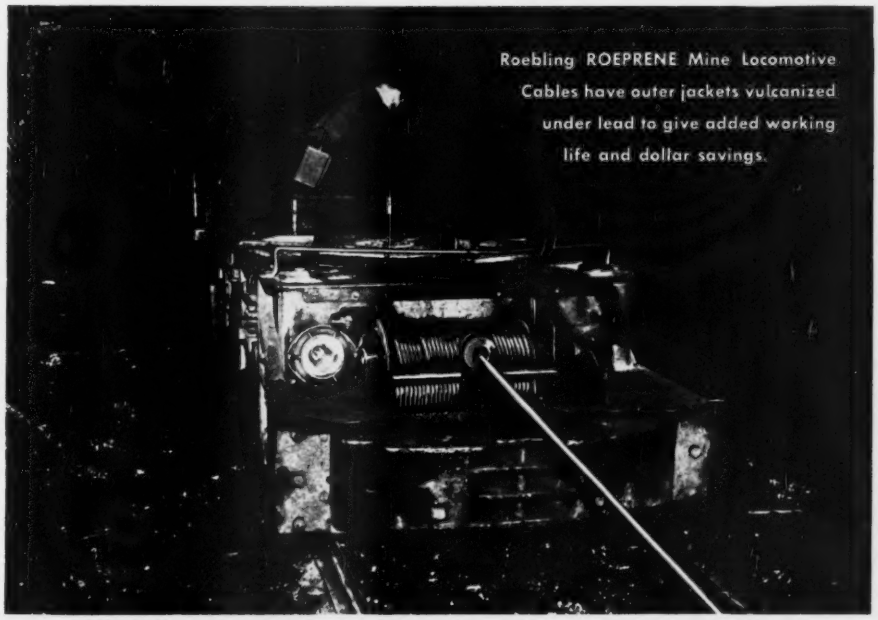

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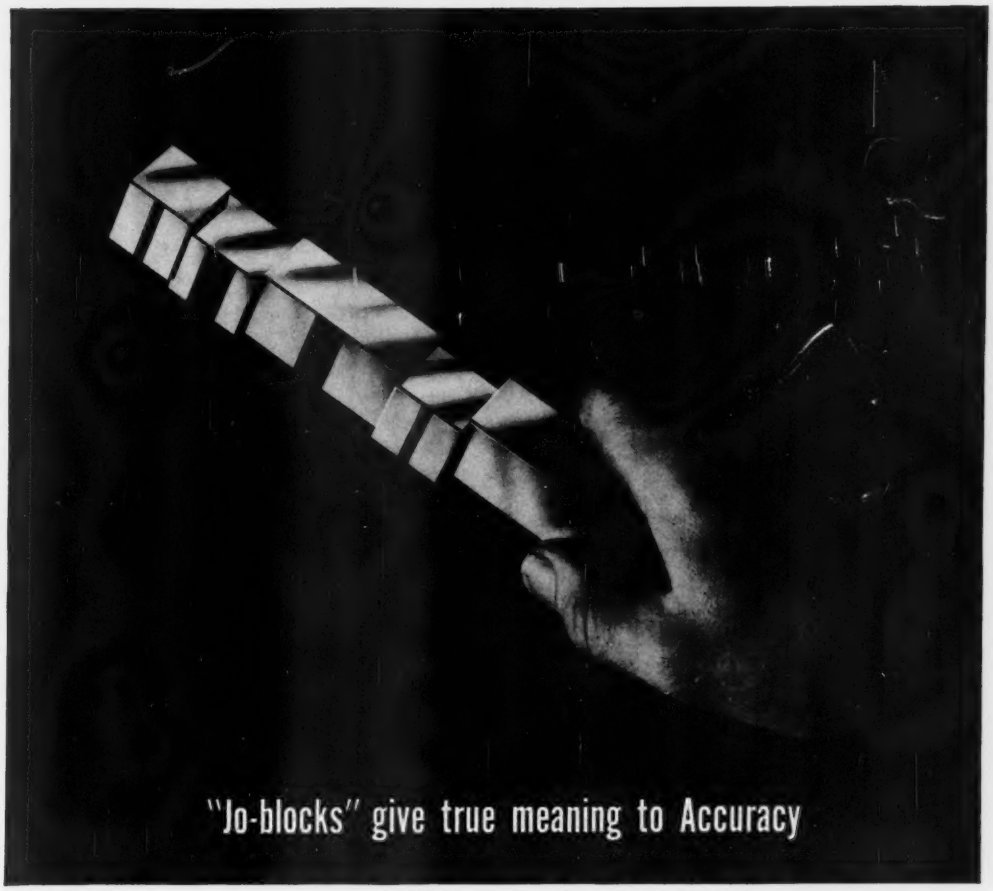

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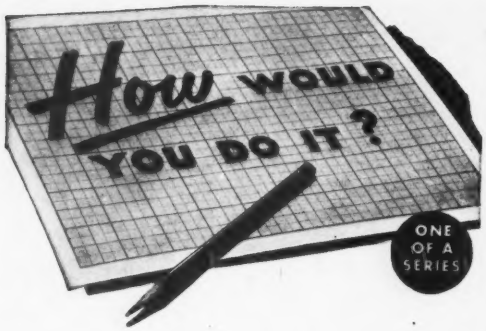

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weather rhythms

(*Continued from page 26*)

Glaciers supply still other evidences of climatic cycles. After long periods of cold, snowy weather, glaciers advance; after periods of warm weather, they retreat. Sometimes one advance destroys the evidence of the preceding retreat, but fortunately this is not always the case, and when glaciers are carefully studied, the case for cycles in climate is stronger still.

Layers of plant materials found in the peat bogs of Northern Europe supply still more information. Some layers of such bogs are found to contain large quantities of pollen from pine trees; layers formed in intermediate years contain less pollen. With the aid of botanists, it is possible to determine the character of the climate in the successive years.

Layers of clay deposited in lakes and estuaries, especially those into which glaciers discharge, are an even greater source of information about past climates. Clay deposited in summer differs in color and character from that deposited in winter. By interpreting the character and thickness of the clay layers, geologists have traced with considerable exactness the climatic conditions of Northern Europe for twelve thousand years, back to the time when the glaciers of the last ice age were disappearing. This line of investigation promises to prove the most important of all.

Precisely similar layers of clay and other material are found in rocks, some of them hundreds of millions of years old. The evidence of these rock layers proves that climatic variations have had the same character of moving in cycles for probably a thousand million years of the earth's history. In Australia, the sunspot cycle of eleven years has been identified in rock at least five hundred million years old.

Climatic changes in these great cycles cannot but affect human history. One of the most important historical effects of climatic changes has been the successive waves of migration out of Asia — the outpouring of the hordes of Vandals, Huns, Tartars, Mongols, and so on. These migrations have been going on for thousands of years. When there is a period of plentiful rainfall and food the Asian populations thrive and increase; when the cycle changes, drought and famine sweep the hordes before them, flooding Europe and China.

Another drastic effect was that caused by the disastrous winters which occurred between 900 and 800 B.C. Blond-bearded giants, ancestors of the Vikings, driven from the North by the cold, filtered through the forests to slay the dark-haired lake-dwellers who lived in Southern Europe. All was wrath, war, death. Frost had banished comfort from a continent. The cause of this terrible freak of nature remains unknown to this day.

All over the world are indications of great changes of climate which have destroyed civilization. In the Central American jungles are the ruins of huge cities built by the Mayas, some of which are two thousand years old. The few survivors of that race are virtual savages; their ancestors abandoned thriving cities for no discernible cause except that of climatic catastrophe. In Cambodia, buried in the jungle, are the marble ruins of Angkor the Magnificent, where once a million people lived. In the deserts of Central Asia are still other cities buried in the sands. All their stories are the same.

The laws that determine weather cycles have yet to be formulated, but when such laws are understood, it may be possible to predict not only future weather, but future history.

German crowd, part of the 1,250,000 from East and West Berlin, sees a typical RCA television program.

"Freedom's window in the Iron Curtain"

You've read the story of last summer's TV demonstrations in Berlin. It attracted a million and a quarter Germans – including thousands who slipped through the Iron Curtain to see Western progress at work.

Behind this is another story: How RCA engineers and technicians broke all records in setting up these Berlin facilities. The project called for a TV station and studio, a lofty batwing antenna, and the installation of 110 television receivers at strategic points. Such a program would normally take several months to complete. It was installed and put to work by RCA in a record-breaking 85 hours!

Programs witnessed by Berliners included live talent shows, sports events, news commentaries, and dramatizations of the Marshall Plan. Observers pronounced reception fully up to American standards – another impressive demonstration of democracy's technical ingenuity and leadership.

• • •

See the latest wonders of radio, television, and electronics at RCA Exhibition Hall, 36 West 49th St., New York. Admission is free. Radio Corporation of America, RCA Building, Radio City, New York 20, N. Y.

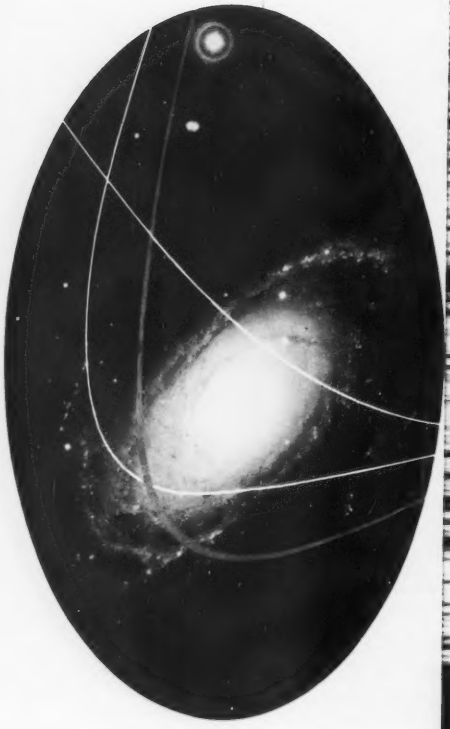
Continue your education with pay—at RCA

Graduate Electrical Engineers: RCA Victor—one of the world's foremost manufacturers of radio and electronic products—offers you opportunity to gain valuable, well-rounded training and experience at a good salary with opportunities for advancement. Here are only five of the many projects which offer unusual promise:

- Development and design of radio receivers (including broadcast, short-wave and FM circuits, television, and phonograph combinations).
- Advanced development and design of AM and FM broadcast transmitters, R-F induction heating, mobile communications equipment, relay systems.
- Design of component parts such as coils, loudspeakers, capacitors.
- Development and design of new recording and producing methods.
- Design of receiving, power, cathode ray, gas and photo tubes.

Write today to College Relations Division, RCA Victor, Camden, New Jersey.
Also many opportunities for Mechanical and Chemical Engineers and Physicists.

RADIO CORPORATION of AMERICA
World Leader in Radio — First in Television

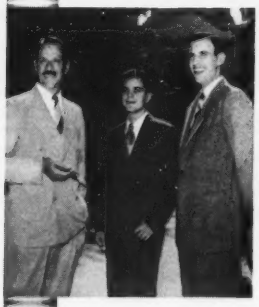


to be always beyond the frontier

Modern industrial research must constantly explore far beyond outposts of the known. For through this tireless reaching past existing scientific frontiers, the impossible of today becomes the reality of tomorrow.

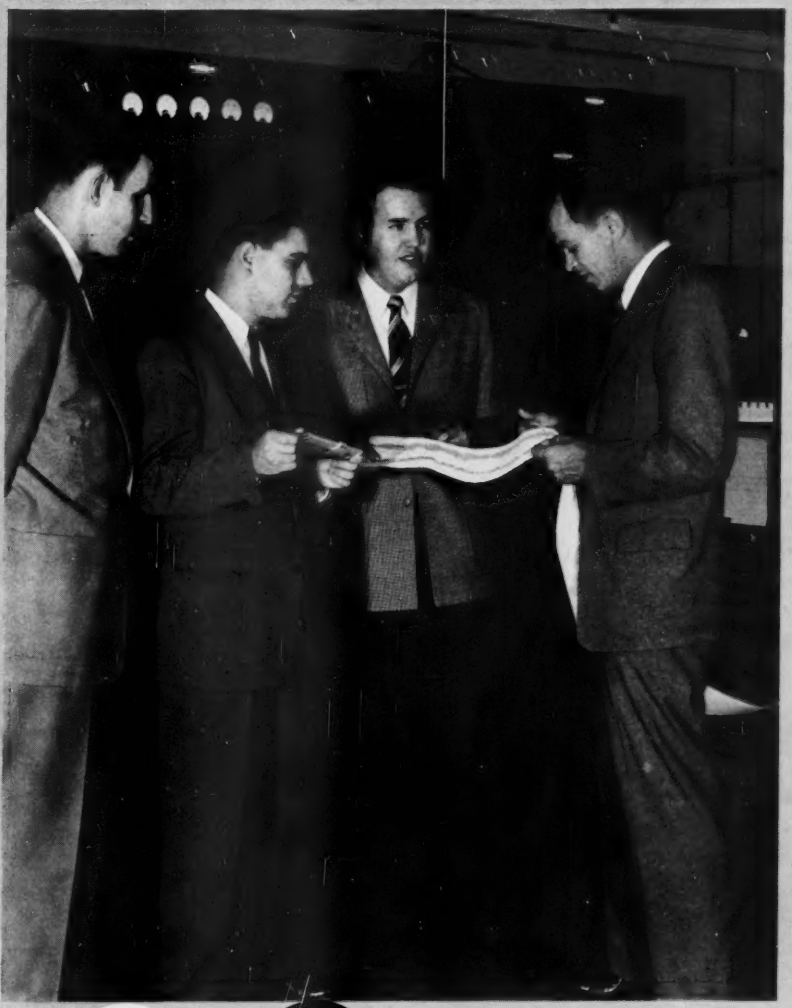
The Howard Hughes Fellowships in Science and Engineering were established at the California Institute of Technology to encourage such creative industrial research and development. Any American citizen is eligible for a Fellowship who qualifies for graduate standing at the Institute for study toward the degree of Doctor of Philosophy with a major in physics or engineering.

Each Fellowship covers a twelve-month period. A portion of it is spent in advanced work in the Research and Development Laboratories of Hughes Aircraft Company. A Fellowship award provides a money gift, salary, and tuition and research expenses.



Dr. Clark Millikan (left) of the California Institute of Technology welcomes to the campus Hughes Fellowship recipients Art Bryson from Illinois and Warren Mathews from New Jersey.

Hughes Fellows Warren Mathews and Art Bryson are shown (left to right) with Dr. Robert R. Bennett and Dr. Allen E. Puckett examining the results of some random noise studies made with use of electronic analog computer in Hughes Research and Development Laboratories.



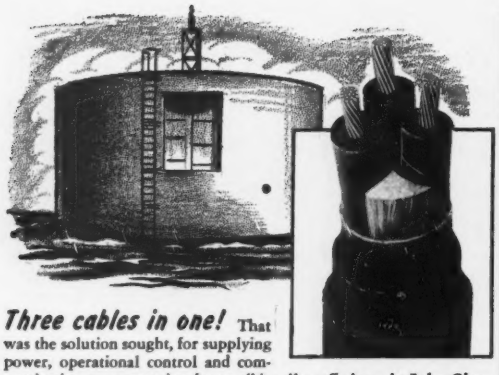
HUGHES

AIRCRAFT COMPANY

Culver City
California

How to apply for a Fellowship:

Write Howard Hughes Fellowship Committee, Hughes Aircraft Company, Culver City, California, for application blank and brochure giving further details. Completed applications must be received by the Committee not later than January 7, 1952.



Three cables in one! That was the solution sought, for supplying power, operational control and communication to a pumping house 4½ miles off shore in Lake Okeechobee, Florida.

As usual, Okonite engineers were consulted on the problem. Their studies showed that it was possible to combine a three-fold function in one cable. This was accomplished by the use of Okolite high-voltage insulation whose electrical characteristics permitted carrier current to be superimposed on the power conductors.

The result was a single Okonite-insulated cable—steel-armored for the 4½ underwater miles, with a non-metallic sheath for an additional 2½ miles underground—which supplies not only power and operation control, but a communication circuit as well.

• • •

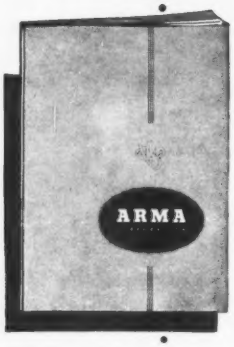
Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

This booklet...

"Engineering at Arma"

...may open New Horizons for you



Write for your copy of this booklet, and learn the many advantages of an engineering career with this 33-year-old leader in the design, development and production of the complex electronic instruments required by our modern Armed Forces and industry. Engineering Division, Arma Corporation, 254 36th Street, Brooklyn 32, New York.

QUALITY ARMA PRECISION INSTRUMENTS

amateur radio

(*Continued from page 14*)

you are interested in what type of show "Amos 'n' Andy" will present next week, just call "Amos" or, better, amateur radio station W6QUT. If you want some information about the air force call Lt. Gen. Curtis Le May, radio amateur station D4AFE. One of the youngest hams on the record was, and I believe still is, little Jean Hudson of Laurel, Delaware. She mastered International Morse Code by the time she was eight and was soon operating her own licensed station.

The ham wallpapers his shack with hundreds of "QSL's" — cards exchanged through the mail between hams after they have talked to each other. Every ham's QSL is as distinctive as a woman's new suit or a man's new tie. Call letters (which identify the station) are of vivid multiple colors. The amateur who operates station VR6AA on Pitcairn Island in the Pacific used tropical leaves for his QSL cards.

Through the air waves there is a lot of personal chitchat or "rag chew." The ham may discuss politics, the latest football game, the girl friend, but one of the most important topics of conversation is the never ending technical exchange of information about such things as "narrow band frequency modulation" or "superinfragenerative converters." If an amateur dreams up a new device he will try to spread the news far and wide.

In the U. S. A. the Federal Communication Act lodges in the Federal Communications Commission authority to classify and license radio stations and to prescribe regulations for their operation. Pursuant to the law the FCC has issued detailed regulations for the amateur service.

Amateur radio licenses are given to United States citizens who pass an examination on operation of apparatus and on the provisions of law and regulations affecting amateurs, and who demonstrate ability to send and receive the International Morse Code at a speed varying from five to thirteen words per minute. The ham may not broadcast entertainment or advertising, nor may he accept remuneration for his services. Any obscene, indecent or profane language results in immediate confiscation of his license. If the FCC or one of the government's monitoring posts across the nation doesn't catch up with infraction of these rules, brother hams soon will. They have an enviable record of self-discipline.

Here at M. I. T., W1MX, the oldest college amateur short wave transmitting station in the world, is a part of the "Ham Fraternity." For five years, beginning in 1922, it was the frequency standard for the United States, the third to cross the Atlantic and the first to be heard as far away as Hawaii. It has almost always been in operation during national emergencies.

The station itself has eighty-four members, some of whom have licenses and some who are trying to learn enough to get one in the near future. W1MX has recently become part of a network of amateur short wave operators whose main purpose is to send messages back and forth across the country. Thus telegrams can now be sent free of charge from the Institute to any part of the United States.

So you see that amateur radio can be important in many ways: for communication in time of disaster, as valuable training for future communications experts, and as a means of furthering international understanding. But, above all, it is a fascinating hobby, and this is the reason for its wide popularity.

Small Change adds up to Millions

Perhaps you've noticed that lamp bases, traditionally made of brass, now are being made of aluminum. There's a story behind this change and it tells a lot about the kind of jobs going on at Alcoa.

It started several years ago when engineers of two leading lamp manufacturers agreed with our suggestion that bases of aluminum would cost less. "But will they be as good . . . will we have to revise our methods?" they asked.

The potential savings, a few mills per lamp times the 830 million sold each year, made finding the answers worth-while. Together we started two long-range research projects. One, to test aluminum alloys in the weather, fumes and years of standing idle that lamps must endure. The other, to find the alloy that would take five progressive draws, then thread rolling and finally, the high temperature of the red-hot glass that is poured in the base.

We tested samples, changed alloys, varied tempers, rolled different thicknesses. Lamp manufacturers tried each, until one met all requirements. Our development men worked long hours to get the right solder and flux to join the side wire to the base. Adapted them to the high-speed, lamp-making machines.

All this time, the manufacturers had aluminum bases installed in seacoast and industrial atmospheres. Our laboratories ran other tests on lit and unlit lamps under corrosive conditions. After 1½ years the reports came in: Aluminum bases measured up in every respect: conductivity, corrosion resistance, ease of installation and removal.

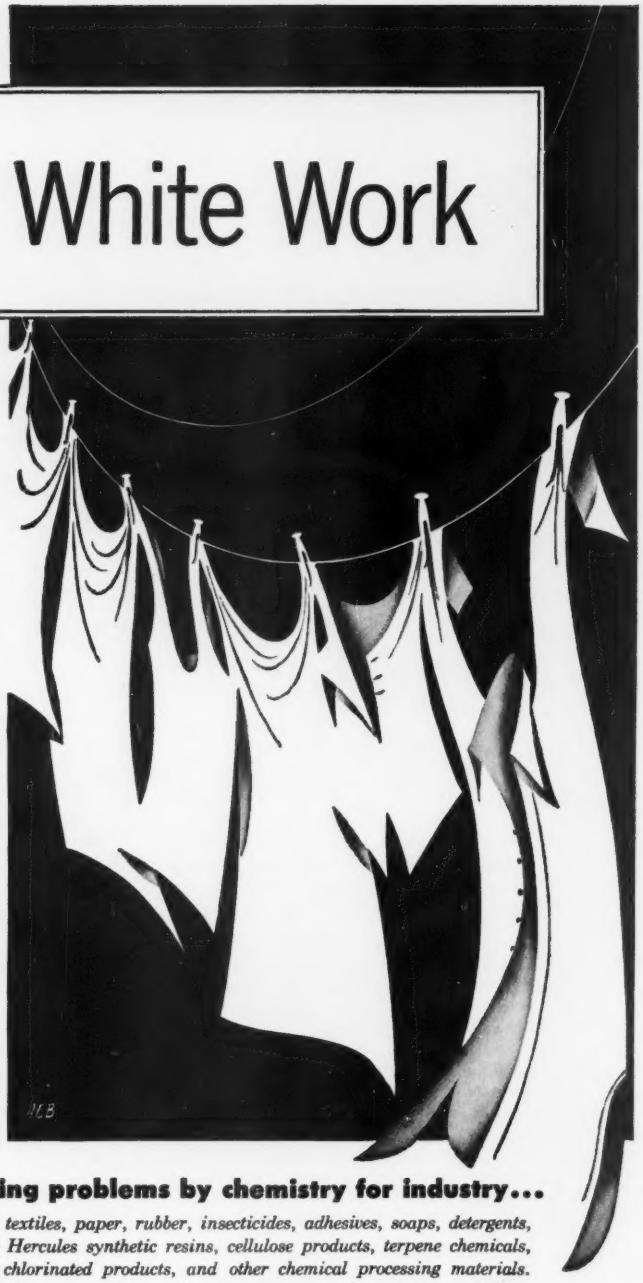
This is typical of the research and development jobs now underway at Alcoa. And others are waiting for the men with the skill and imagination to tackle them. ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pennsylvania.

A business built on co-operation

ALCOA®

ALUMINUM COMPANY OF AMERICA

Whiter White Work



CHEMICAL PROBLEM...

. . . laundry detergents to wash clothes whiter without increasing laundering costs.

SOLUTION...

. . . a Hercules cellulose derivative called CMC-CT . . . a special form of cellulose gum. Now a standard ingredient in many leading brands of "soapless soaps," its unique action floats dirt away from the clothes and prevents it from getting back during the wash, thereby improving whiteness.

COLLEGE MEN...

This is but one example of the far-reaching chemical developments in which you could participate at Hercules—in research, production, sales, or staff operations. It suggests the ways Hercules' products serve an ever-broadening range of industries and end-uses.

Hercules' business is solving problems by chemistry for industry...

. . . paint, varnish, lacquer, textiles, paper, rubber, insecticides, adhesives, soaps, detergents, plastics, to name a few, use Hercules synthetic resins, cellulose products, terpene chemicals, rosin and rosin derivatives, chlorinated products, and other chemical processing materials. Hercules explosives serve mining, quarrying, construction, seismograph projects everywhere

HERCULES

HERCULES POWDER COMPANY Wilmington, Del.
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make
LOCKHEED'S
great future

YOUR FUTURE

There's a better future—a better job—waiting for engineers at Lockheed Aircraft Corporation, in beautiful San Fernando Valley. At Lockheed you are well-paid from the start; work in modern, air-conditioned offices; receive training that prepares you for promotion—you are part of a team known for **leadership in aviation.***

These Lockheed planes show why Lockheed and Lockheed engineers – earned that reputation for leadership.

THE VEGA—
flown to fame by Charles Lindbergh, Amelia Earhart, Wiley Post.

THE HUDSON BOMBER—
first American plane to fight in World War II.

THE P-38 LIGHTNING—
first 400 mile-per-hour fighter-interceptor.

THE F-94—
first all weather jet interceptor assigned to duty with America's aerial defense forces.

THE SUPER CONSTELLATION—
larger, faster, more powerful; the plane that bridges the gap between modern air transport and commercial jet transport.

The jet of the future—the plane you will help create—belongs in this frame. There will always be empty frames like this, waiting to be filled by Lockheed engineers. That's why Lockheed will always need forward-looking engineers. So why not make Lockheed's great future **your** future. See your placement officer for illustrated brochures explaining work—and life—at Lockheed.

If your placement officer is out of brochures, write:

M. V. Mattson
Employment Manager

LOCKHEED
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***Aeronautical training is not necessary; Lockheed will train you.**

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When manufacturing processes require *only* high-test mineral-free water, Barnstead Demineralizers are the best producers . . . 5c per 1000 gallons of demineralized water with a minimum of supervision and maintenance. Barnstead Demineralizers increase production, reduce rejects and insure better products control.

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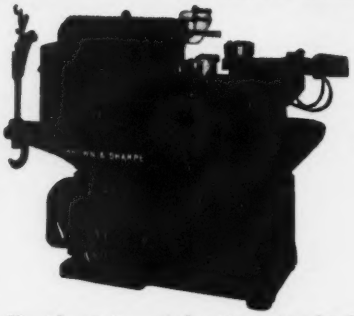
★ Barnstead STILL & STERILIZER CO. ★

45 Lanesville Terrace, Forest Hills, Boston 31, Mass.

NEW BROWN & SHARPE HAND SCREW MACHINES



Handle Short-Run Jobs More Profitably

Nos. 00, 0 and 2 Brown & Sharpe Hand Screw Machines produce small-quantity bar-stock and second-operation jobs with high economy and efficiency. Write for detailed literature on these modern cost-cutting machines which take stock from ⅜" to 1" diameter. Brown & Sharpe Mfg. Co., Providence 1, Rhode Island, U.S.A.

BROWN & SHARPE

WHAT IS "SURFACE FINISH" IN A BEARING ?

No bearing can be accurate and smooth-running unless it has a fine finish, particularly in the races. It is this plus-quality in the finish of SKF Bearings that means smooth-running bearings—smooth-running machines. SKF Industries, Inc., Phila. 32, Pa. 7180

SKF
Ball and Roller Bearings

the "brush-off" in a nice way

(*Continued from page 15*)

fiber comes from a tall, picturesque palm that grows in the hotter parts of India, the Malay Peninsula, and the Dutch East Indies.

Rattan core, or China weed, is made from species of palm that grows in the Philippines. It is used for the big bristles of street sweepers' brooms and the big cylindrical brooms of rotary street-sweeping machines. Split bamboo is used in much the same way as rattan core.

When trade conditions were normal, the United States got horsehair for brushes from the principal nations of the world. The bulk of it came from China, but Australian horsehair was generally rated best. The value of horsehair is governed by its stiffness and color. One tail produces approximately one pound of dressed horsehair, ready for brush making. Badger hair, such as used in shaving brushes and other fine brushes, is expensive. The best of it comes from the Balkans, Russia and Siberia. Artists' brushes are often made out of goats' beards and selected hairs from the ears of oxen.

When you tossed the shoebrush in the corner this morning, you tossed the labors of Chinese coolies and Indian natives. Your shaving brush traveled half way around the world to lather your face.

The brush painting your house has more than thirty thousand bristles raised on hogs in the rice paddies of China, and your younger sister's water-color brush was plucked from the tail of a squirrel trapped in the snow of a Siberian winter.

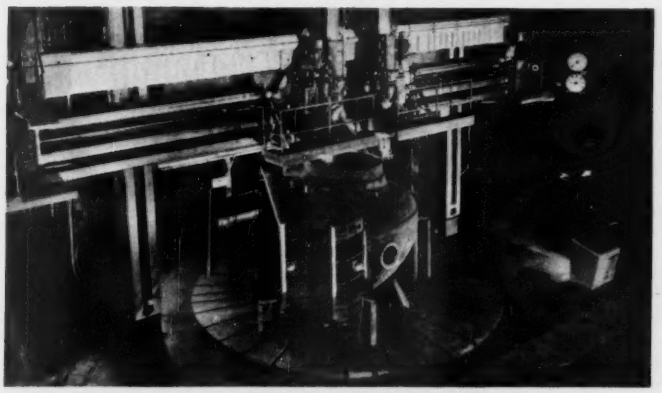
The humble brush has truly become an instrument of precision.

Behind Every Success There's
PLANNING

H. V. FULLER

by H. V. FULLER, *Supt. Time Study and Planning Dept.*
General Machinery Division, ALLIS-CHALMERS MANUFACTURING COMPANY (*Graduate Training Course 1939*)

PLANNING is an important part of manufacturing machinery—and of building a career, too. This planning, however, must be based on information and experience. You don't always have all the facts about industry that you need at the time you leave engineering school and start planning your own future. At least, that's the way it was with me when I got my degree in Mechanical Engineering at University of Wisconsin in 1936.



New 30-ft. boring mill now operating in Allis-Chalmers' West Allis shops. It supplements older, slower 40 ft. mill, and greatly increases capacity on big, heavy work. Both mills are scheduled practically around the clock, seven days a week.

I took a job with a big manufacturer, but within a year the work I was doing ended, and my employers referred me to the Allis-Chalmers Graduate Training Course. I enrolled in 1937—and then my knowledge of industry really began to grow. There was the usual round of the plant—shops, offices, various departments—where I saw a wide range of work at first hand. I worked with steam turbines, pump testing, and on the electrical test floor. About half way through the two-year course I got really interested in the manufacturing side of the business. After four months of plant layout work I went to the Time Study and Planning Department, and finished out my course there in 1939. In 1945 I became Superintendent.

This Is the Starting Point

In this department we really start the manufacturing operation. We're given the engineering drawings and material specifications. And from this data we plan the sequence of manufacturing operations—determine the equipment and tooling required, and set up time standards for each operation.

You can get some idea of the volume of work from the fact that our West Allis Machinery Division shops ship an average of eight million pounds of finished machinery per month—representing a range of products from small V-belt sheaves to massive crushers, steam and hydraulic turbo-generating units, cement kilns, sewage pumps, motors, flour mills, and power transformers.

Look Before You Decide

As a Graduate Training Course engineer here you may become interested in manufacturing. There's a great need for trained engineers in this work. Or, you may find your interest lies in some other field—designing, research, sales, personnel, service and erection. In any case, the Graduate Training Course gives you a chance to look them all over, gain practical first-hand experience, plan your career on a sound basis of knowledge.

Do Your Own Planning

The course is flexible—you help plan it yourself and can change it as new interests or opportunities develop. There's no other spot in industry that offers such a wide range of experience—so many choices for a career.

* * *

If you want to get further details as to qualifications, salary and operation of the course, get in touch with any Allis-Chalmers district office. Probably the manager was a G T C himself. Or, write for literature.

*

One of the three 6000 kw 3-machine Allis-Chalmers motor-generator sets in large Eastern steel mill. These units provide direct current for motors driving 68-inch hot strip mill.

*

ALLIS-CHALMERS *Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin*

briefing the news

Electronic Calipers . . .

A "look" from a pair of electronic eyes is all that it will soon take to measure the width of red-hot steel strips moving through rolling mills.

The eyes are the principal part of a new device which for the first time will automatically and continuously measure the width of red-hot steel strips without physically contacting the metal.

Preliminary tests indicate that use of the gage will result in increased production of finished steel with less scrap loss. The new device is described as an electronic width gage for hot-strip steel rolling mills.

Closer tolerances expected from use of the new gage, calculated to be accurate within plus or minus one-eighth of an inch, will save much time and scrap waste by eliminating excessive edge trimming.

The new non-contacting gage can continuously measure, indicate and record steel strip width by means of two electronic detectors mounted about fifteen feet above the rolling-mill table.

The electronic detectors, filling the role of eyes, "gaze" at edges of steel strips as they move under the gage. An optical lens, mounted in each detector, reflects the image of each edge of the strip. Necessary illumination for the reflecting image is furnished from the glowing strip.

The detector system converts the image of each strip edge into an electrical pulse signal. Both pulse signals are then automatically added together and can be recorded. Resultant chart readings can then give a continuous width record of all steel strips rolled. Any deviation from a preset desired width immediately shows on a "deviation indicator."

Vertical or sideways motion of the strip has little effect on accuracy of the gage. If the steel strips shift on the rolling-mill table, pulse signals from one detector become longer, while pulse signals from the other detector become shorter. The sum of the signals, automatically added, will remain the same.

Currently-used width measuring methods require manual spot-checking which does not provide a continuous check of width. A steel worker, shielding himself from the intense heat, periodically measures the red-hot moving strips with a pair of calipers. This usually makes it necessary to stop the moving strips.

The new gage will save time and insure width accuracy by continuous measurement while the rolling mill is in operation. Easy installation and low upkeep costs of the gage make it adaptable to existing mills without modification of the mill equipment.

"Artificial Respiration" of Jets . . .

Starting jet engines by "artificial respiration" has been tested successfully in Korea, the General Electric Company disclosed today with Air Force permission.

The method, in which exhaust blast from one jet is used to start another directly behind it, was described by the Company's Aircraft Gas Turbine Divisions as "an apparently practical means of starting jet aircraft at advance bases where external power units are unavailable, or in extremely cold weather where effectiveness of such starting sources is reduced."

Jet aircraft usually rely upon field power units for starting, rather than their own electrical systems, because of the large amount of power required.

The tailpipe of the operating jet was aligned directly in front and some distance ahead of the air intake of the plane to be started. The interval was selected to protect the pilot and airframe of the aircraft from the high-temperature exhaust gases of the plane ahead. The pilot wore an oxygen mask as an added protection in the initial test.

When the engine of the lead plane was accelerated to full power, the exhaust blast was sufficient to windmill the power-plant of the "disabled" aircraft to more than initial firing speed and a normal start was made. There was no evidence of excessive heat or blast effect on the aircraft or engine of the aircraft being started.

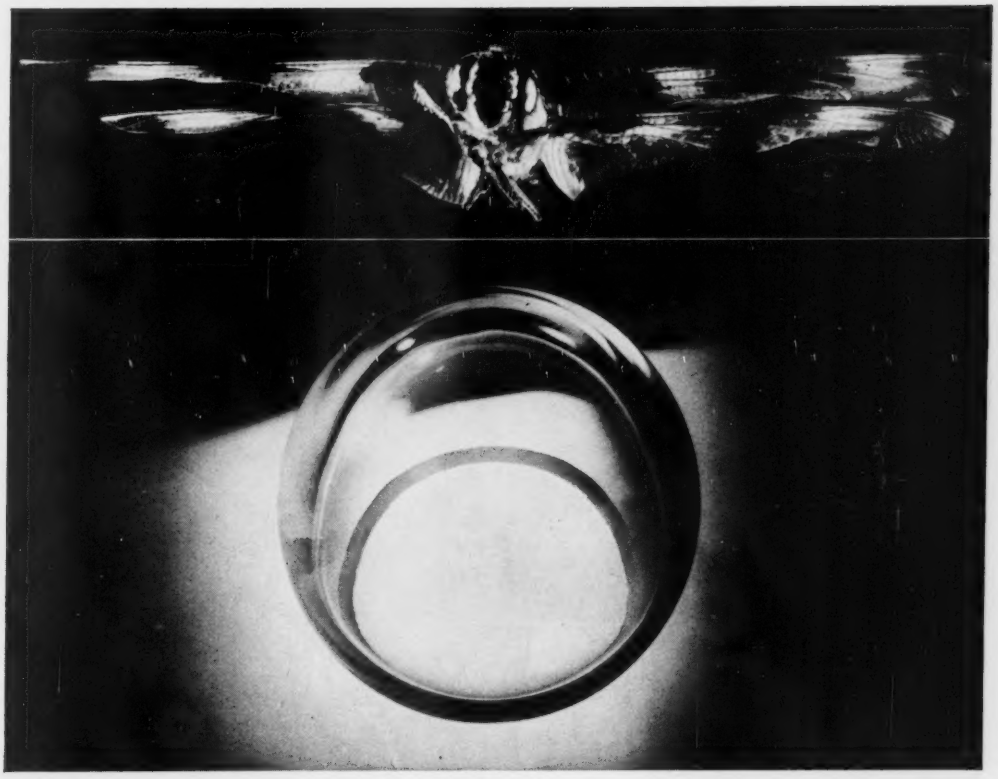
Remote Control Steering . . .

Steering a ship by remote control from practically any strategic spot on board has been made possible by a new device called the "electric helmsman" developed by General Electric Company engineers.

Primary use of this unit would be during combat operations when the normal steering stations had been disabled by enemy fire. In addition, the device can be utilized for effective "close-in" direction of intricate maneuvers such as docking, breeches buoy transfers, and other normal or emergency movements.

The new instrument is controlled by a small knob located on the top of an enclosure which is strapped to the user's chest. The instrument is plugged into the steering control system at special outlets located at widely separated positions throughout the ship. From these points, it is electrically coupled with a special steering power unit in the steering engine room where the rudder mechanism is located.

The unit is now being fitted on a destroyer for Navy use. An earlier model has been successfully tested on a similar naval vessel during the past two years.



Dragonfly eye for a war plane—blown of optical glass

As any naturalist can tell you, the dragonfly has one of the best eyes there is for seeing.

His eye is a button, set well out from his head. It lets the dragonfly see in all directions without craning his neck.

Now war-plane pilots aloft have just such a convenient eye to see with—the glass bubble shown above. Set in the skin of a plane—and fitted with an optical system—it gives a clear, horizon-sweeping view.

This new kind of eye for war planes marks the *first time* in the history of glass-making that perfect optical glass has been mass-produced by blowing. And because the blowing is so accurate, the bubble needs a minimum of grinding and polishing to meet exact optical specifications.

Before such a bubble could be blown, Corning had first to develop ways of forming optical glass shapes directly from the molten glass. This was accomplished during World War II, when Corning devised a method of manufacturing lens blanks of perfect optical glass by machinery.

Today, shaping optical glass by blowing greatly extends the usefulness of optical glass for industry as well as the Armed forces.

Making optical glass more useful is just *one* way that Corning, in a full century of glass-making, has helped glass become one of today's most versatile engineering materials. Corning has developed more than 50,000 formulas for making glass, and they are being added to, day by day.

Throughout industry, *Corning means research in glass*—research that is constantly turning up new ways to make glass do countless jobs better than they've ever been done before.

So after you're out of college and are planning new products or improved processes, it will pay you to call on Corning before you reach the blueprint stage. *Corning Glass Works, Corning, N. Y.*

CORNING
means research in glass

1851—100 YEARS OF MAKING GLASS BETTER AND MORE USEFUL—1951

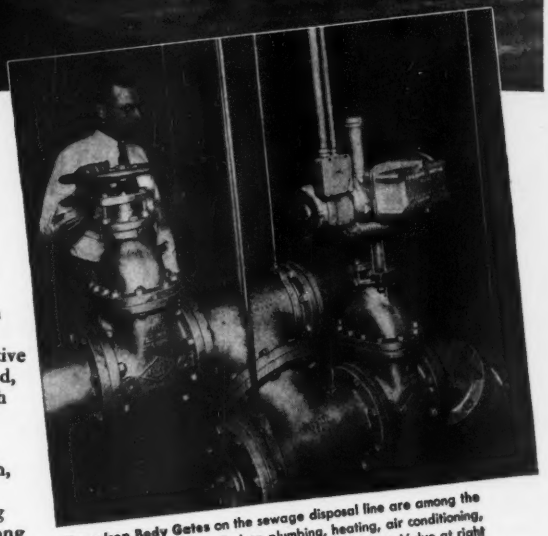
Architect: THE ARCHITECTS' COLLABORATIVE, CAMBRIDGE, MASS.
Technical Associates: BROWN, LAWFORD & FORBES, NEW YORK, N. Y.
General Contractor: GEORGE A. FULLER COMPANY, BOSTON, MASS.
Heating Contractor: FRED WILLIAMS, INC., BOSTON, MASS.
Plumbing Contractor: JAMES A. COTTER COMPANY, BOSTON, MASS.
Mechanical Engineer: CHAS. T. MAIN, INC., BOSTON, MASS.

Work of a team of architects, led by Prof. Walter Gropius, the new Harvard Graduate Center, Cambridge, Mass., is in itself an "education" in modern planning. Providing an entirely new environment for communal living, where cooperative activity and interchange of ideas may be encouraged, it is an architectural setting completely in tune with the times.

The same future-minded planning was devoted to such engineering problems as heating, sanitation, and air conditioning for the eight integrated Dormitory and Commons buildings. All operating equipment was selected for highest efficiency and long life. On this basis, Jenkins Valves were installed.

To the long list of college and school buildings throughout the nation equipped with Jenkins Valves, the new Harvard Center makes a notable addition. On their record, Jenkins Valves are being specified, also, for more and more of the new plants, the new commercial, institutional, and municipal structures that are setting new standards for operating efficiency, as well as architectural design.

In fact, to future-minded building planners, the Jenkins Diamond has become the *guide* to lasting valve economy . . . not only for new installations, but for all replacements. Jenkins Bros., 100 Park Ave., New York 17: Jenkins Bros., Ltd., Montreal.



These Iron Body Gates on the sewage disposal line are among the many Jenkins Valves installed on plumbing, heating, air conditioning, fire protection and other essential pipe lines. The Gate Valve at right is motor-operated, and closes automatically if flood conditions threaten backup into system from city sewage lines. Standing, Mr. Donald E. Robinson, Foreman of Plumbing Dept., Maintenance Division.

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THE DU PONT DIGEST

M.E.'s AT DU PONT [3]

Plant engineering and production supervision offer interesting careers for science graduates

In the past two issues of the *Digest* you've read of the broad opportunities that are offered mechanical engineers in research and development work at Du Pont.

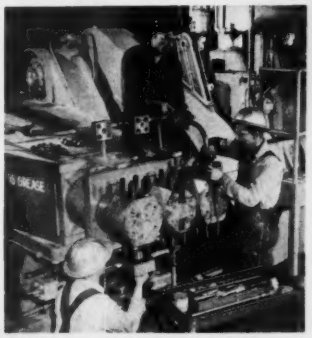
This month let's look at opportunities for men interested in any of the branches of plant engineering —such as maintenance, power, design and construction—or in production supervision.

Efficient maintenance is an important cost factor in the continuous processes of a modern chemical industry. The M.E. is called upon to diagnose troubles, work out corrective measures, and supervise repairs.

Frequently he increases production by developing preventive maintenance measures. So vital is this work that in one division of the Company, 500 men of all crafts, along with a routine maintenance group, spend almost all their time on it.

One example of the problems facing Du Pont engineers is the maintenance of pumps made to tolerances of 0.0001" and operating at pressures up to 6000 p.s.i.

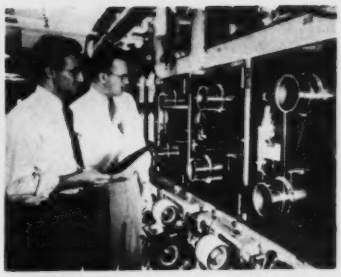
In power work, also, problems requiring application of mechanical engineering principles arise. For instance, a metal required in one chemical process is melted at 800°F. by immersion heaters fired by butane, which is expensive. Conversion to fuel oil presented the problem of complete combustion in the immersion chamber. Du Pont M.E.'s redesigned the heaters so combustion could be complete and the hot gases recycled in water to use all the available heat.



OVERHAUL *on polythene area injection pump is six-hour job for three men. Work must be scheduled for minimum disruption of output.*

A FIREMAN *adjusts louvers for the proper combustion of pulverized coal. Blown into furnace through pipes, it burns at 2500°F.*

In design and construction of chemical plants, mechanical engineering again is of major importance because of the wide variety of plants built and intricacy of their equipment. Engineers collect basic data, design and select equipment. They also supervise many steps of construction until the plant is operating.



F. E. SPELLMAN, JR., *B.S.M.E., M.M.E., Ohio State '51, and D. A. Smith, B.S.M.E., Purdue '40, discuss a change in feed wheel design of nylon spinning machine.*

Production supervision attracts many mechanical engineers. Men who have the ability and interest usually move into it by one or two routes: they acquire background on all stages of a plant's operations by helping design the plant, or by operating on the job.

MAINTENANCE TEAM *making a speedy change of a methanol valve to minimize production loss.*

Sometimes students of mechanical engineering feel that in a chemical company they will be overshadowed by chemical personnel. This is not the case at Du Pont. Here, hundreds of administrators and supervisors, up to the rank of vice-president, started as M.E.'s.

Opportunities for men and women with many types of training are described in the 40-page brochure "The Du Pont Company and the College Graduate." For your free copy, address 2521 Nemours Bldg., Wilmington, Del.

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Trekking long distances in the frozen North, on a trapline or behind a dogsled, demands stamina! And, just as surely, pipe *must* have stamina to serve for a century or more as cast iron water and gas mains are doing in more than 30 cities in the United States and Canada. In the generations since these gallant old mains were installed, horse-drawn vehicles have given way to multi-ton trucks and buses. Under the streets crowded utility services have been constructed. Yet cast iron pipe has withstood the resultant traffic-shock and beam-stresses because of its shock-strength, beam-strength and crushing-strength. *No pipe, deficient in any of these strength-factors of long life, should ever be laid in paved streets of cities, towns and villages.*

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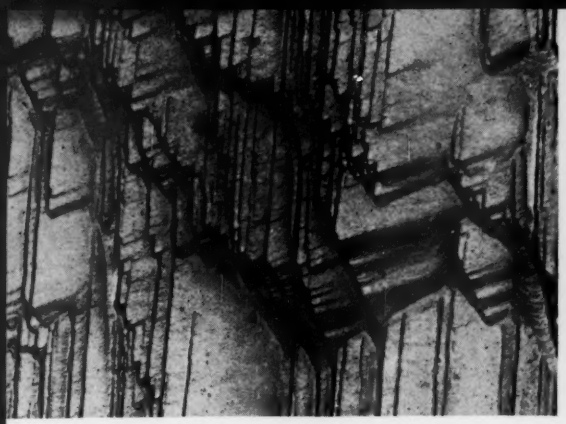
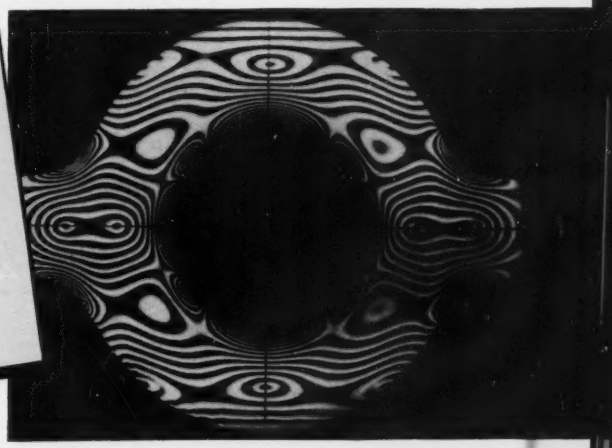
Cast Iron Pipe Research Association, Thos. F. Wolfe, Managing Director, 122 So. Michigan Ave., Chicago 3.



REVEALS NEW FACTS ABOUT METAL STRUCTURE. Electron micrography—up to X50,000 with the electron microscope—reveals new facts about metal structure, surface protection, and effect of processing procedures.

DETERMINES COMPOSITION OF MATERIALS. The composition of almost any material is shown in a flash through spectrography. It is a means of making frequent production line analyses that keep a check on specifications.

Engineering has an ally in photographic analysis



SHOWS STRESSES AND STRAINS VISUALLY. By photographing the patterns developed by polarized light as it passes through a plastic model of a part, the engineer can have visible evidence of the points of stress within the part.

In the engineering laboratory—on the production line—photography is today an important tool. It searches metal structure through electron micrography, x-ray diffraction, and micro-radiography. It makes swift mechanical motions seeable by showing them at a snail's pace with high speed movies. Or it can halt an instant of an instrument's fleeting trace and record it for study.

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QUESTION:

What are the advantages of working for a large company?

ANSWERS:

From a poll of college graduates with ten years' experience at General Electric

In order of mentions:

1. *Greater variety of opportunities.* Sample quotes: "More chances of getting into a type of work you will thoroughly enjoy." "Wider choice of jobs." "Plenty of opportunity to find the right job." "There are more opportunities for potential managers than there are candidates." "All sizes of puddles for all sizes of frogs." "More opportunities becoming available due to expansion, transfers, retirements."

2. *Greater opportunity for adjustment.* "G.E. goes out of its way to find the corner you are happiest in and best suited for." "Didn't have to decide on a particular specialty until I had looked the field over." "You can investigate many types of work before choosing your own special field." "Chance to change jobs without losing advantages connected with length of service." "You can change your line of work almost at will without changing employer."

3. *More chance to learn.* "More opportunity to get a good orientation and training program." "Unlimited training." "Better organized and planned training courses." "Opportunity of finding the best of training in my chosen field." "G-E training programs a good bridge between college and industry." "Training from experienced men." "Good chance to learn by association with established experts in many fields."

4. *Greater stability and security.* "Business more stable in large company." "Stability—*if* ability is proven." "Progressive policies concerning pensions, health insurance, etc." "Good security if you do a good job."

5. *Broader sources of information.* "Tremendous wealth of scientific knowledge and information no further away than telephone." "Ease of obtaining technical information, special information, services." "Wealth of knowledge and experience to draw from." "Experts available for consultation." "Access to latest and best technical information and ability."

6. *Better facilities and resources.* "Best technical skills and facilities are available." "Good research facilities and projects." "Better facilities for doing a better job." "Best in equipment and facilities." "If an idea or project is worth while and you sell it, there are adequate resources of men, material and financial backing."

7. *High standard of ethics.* "More honest effort to put value into the product." "Most people I know at G. E. are more interested in building good equipment than in profits by any means." "Fair treatment by management." "Near certainty that you will receive fair treatment." "No fear of relatives of the boss getting *my* promotion."

8. *Chance for greater personal prestige.* "Prestige of working with a company known nationally and internationally." "Friendships all over country among people of your own background and education." "Community recognition."

You can put your confidence in—

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